THE 2004 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM IN YOSEMITE NATIONAL PARK

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EXECUTIVE SUMMARY

Overview

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public and private agencies and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations. The purpose of MAPS is to provide annual indices of adult population size and post-fledging productivity, as well as estimates of adult survivorship and recruitment into the adult population, for various landbird species. Broad-scale data on productivity and survivorship are not obtained from any other avian monitoring program in North America and are needed to provide crucial information upon which to initiate research and management actions to reverse the recently documented declines in North American landbird populations. The system of national parks provides a group of ideal locations for this large-scale, long-term biomonitoring, because they contain large areas of breeding habitat for year-round resident, short-distance migrant, and Neotropical migratory landbirds that are subject to varying local landscape-related and global climate-related effects.

A second objective of MAPS is to provide standardized population and demographic data for the landbirds found in local areas or on federally managed public lands, such as national parks, national forests, and military installations. In this light, the MAPS program has been operated in Yosemite National Park for the past 12 years (15 years at one station) with the hope that it will serve as an integral part of the park's Long-Term Ecological Monitoring (LTEM) program. It is expected that information from MAPS will be capable of aiding research and management efforts within the park to protect and enhance the park's avifauna and ecological integrity.

Five MAPS stations were re-established and operated in Yosemite National Park in 2004, at the same locations they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were 1) White Wolf Meadow at 2402 m elevation; 2) Gin Flat East Meadow at 2073 m elevation; 3) Crane Flat Meadow at 1875 m elevation; 4) Hodgdon Meadow at 1408 m elevation; and 5) Big Meadow at 1311 m elevation. The Hodgdon Meadow station was established and first operated in 1990, the Gin Flat East Meadow station in 1998, and the other three stations in 1993.

The goal of this report is to 1) summarize 12 years of MAPS data (1993-2004) from the four long-running stations and seven years of data (1998-2004) from the Gin Flat East station along an elevation gradient in Yosemite National Park; 2) identify declining species in Yosemite National Park that may be in need of management action; and 3) identify the probable proximate, demographic causes (productivity or survival) for these population declines in Yosemite. The long-term goals for the Yosemite MAPS Program are to 1) identify management strategies and formulate management actions to reverse these population declines at several spatial scales: in Yosemite National Park, in the greater Sierra Nevada ecosystem, and in montane western North America as a whole; and 2) evaluate the effectiveness of implemented actions by continuing to monitor the targeted vital rates.

Adult Population Sizes and Productivity in 2004 and Comparison with Previous Years
A total of 2644 captures (representing over twice the number recorded in 2003) of 66 species was recorded during the summer of 2004 at Yosemite National Park. Breeding populations in Yosemite National Park increased by a non-significant 10.7% in 2004 as compared with those of 2003; increases were recorded at all stations except Big Meadow. Productivity, however, showed an enormous, significant, station-wide increase of 113.5% from a reproductive index (young/adult) of 0.561 in 2003 to 1.198 in 2004. These are exactly opposite to the changes observed in 2003, when all stations except Big Meadow showed population declines and all stations showed significant productivity declines as compared with 2002.

It is relatively unusual to see both population size and productivity decrease in a given year, and even more unusual to then see both population size and productivity increase the following year, as has happened in Yosemite over the past two years. More often, alternating cycles of population increases and decreases with out-of-phase decreases and increases in productivity are observed at most MAPS locations across the continent. These alternating out-of-phase patterns are apparently caused by density-dependent effects on productivity and recruitment along with lower productivity of first-time breeders, and are typically reflected by positive productivity-population correlations.

Although productivity-population correlations over the 12 years, 1993-2004, were positive at Yosemite for 18 of 28 species and for all species pooled, generally supporting the idea that changes in productivity one year bring about corresponding changes in population size the next year, the productivity-population correlations at Yosemite were generally weaker than those at other national parks, including both Denali and Shenandoah. In addition, alternating out-of-phase patterns in population size and productivity have been seen at Yosemite only during certain years, for example between 1996 and 2001. Such dynamics appear to be less strongly manifest in areas, such as Yosemite, that are characterized by high annual variation in weather and snowpack, than in areas where weather is more predictable year-round. It appears that an additional dynamic is operating at Yosemite and in the Sierra Nevada that involves density-independent variation in recruitment rates that is related to climate, weather, and snowpack variables, and that likely affects one-year-old and adult birds differently. Because of the magnitude and unpredictability of such variations in weather (regarding both the extent of and timing of snowmelt as well as summer precipitation and temperatures) and the complex effects these perturbations likely have on avian population dynamics, long, consistent runs of monitoring data and complex modeling of weather variables, climate cycles, and recruitment rates as a function of elevation will be necessary to fully understand the causes of both short-term and long-term changes in Sierra bird populations.

Population and Productivity Trends in Yosemite's Landbirds
Populations of adult birds of all species pooled in Yosemite National Park have shown a substantial and highly significant decrease of -2.7% per year over the 12 years, 1993-2004, indicating a 28% decline during the past 12 years. Population trends were negative at all four long-running stations, being nearly significant at Hodgdon Meadow and highly significant at Big Meadow, and with annual percent declines varying from -1.4% at Hodgdon Meadow to -5.9% at Big Meadow. Adult populations of 19 of 28 target species at the four long-running stations

pooled (and 24 of 37 target species at individual stations) showed declining 12-year trends.

Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata suggests that these dramatic declines for most landbird species in Yosemite are part of a Sierra-wide decline. Predictions from global climate models and recent weather data generally suggest that the Sierra Nevada region is becoming increasingly arid and that this drying tendency may be accelerating. Drier conditions tend to reduce food resources for landbirds; thus, these climate changes may underlie declining landbird populations observed in Yosemite and the Sierra.

In contrast to populations trends, trends in productivity showed a substantial but non-significant 12-year increase of +0.022 per year when all species were pooled. A similar number of species showed increases (15) and decreases (13). For most species and all species pooled, productivity was very low during the summer of 2003, but recovered markedly during the 2004 breeding season when the numbers of young birds captured of all species pooled increased by 136% over 2003. The cause of these huge differences in productivity at Yosemite could relate to differences in the spring snowpack: it reached its peak in 2004 about March 1, whereas in 2003 it didn't reach its peak until about May 15. Accordingly, breeding may have commenced earlier and was more productive in 2004 than in 2003. Over the long term, productivity at Yosemite tends to be higher during El Niño years but the heavy late-melting snowpacks often associated with such years tended to reduce breeding population sizes, at least at higher elevations. To the extent that the frequency and severity of such events is increased by anthropogenic climate change, the effect of such climate change on Sierra landbirds will be deleterious.

Demographics of Yosemite's Birds Along an Elevation Gradient

Species richness (number of species), total adult population size, productivity, and adult population trend at Yosemite each varied with elevation in a unique way. Total species richness of breeding species clearly decreased with increasing elevation, whereas mean annual number of adults of all species pooled was highest at intermediate elevations and decreased progressively both at lower and higher elevations. Mean annual productivity tended to show a positive correlation with elevation, as did station-specific, 12-year population trends (i.e., the trend was non-significantly negative at White Wolf but highly significantly negative at Big Meadow). These correlations suggest that the increasingly negative population trends at lower elevation stations may have been driven by the increasingly lower productivity at those same stations, especially in drought years with meager snowpacks, and may provide further evidence that long-term drying tendencies in the Sierra Nevada may be influencing landbird population declines.

Survival Rates of Yosemite's Birds

We were able to obtain estimates of annual adult survival for 30 target species at Yosemite using 12 years of data from all five stations combined. Mean precision of these survival rate estimates improved from 21.2% (C.V.) in 2003 to 19.3% in 2004, suggesting that maximum precision may not be obtained until more than 12 years of data are available. $\Delta QAIC_C$ values were relatively high in all but two (Lincoln's Sparrow and Dark-eyed Junco) of these 30 species, suggesting that there is relatively little interannual variation in survival for most Yosemite species.

The annual adult survival-rate estimates at Yosemite (1993-2004) appear to be relatively high compared to values for the Northwestern MAPS region as a whole, being higher than in the Northwest Region for 20 of 29 species for which this comparison could be made, and showing a mean survival at Yosemite (0.507) that was 6.7% higher than that of the Northwest Region (0.475). In addition, 11 of 17 species showed higher survival at Hodgdon Meadow than at equivalent elevations in Sequoia/Kings Canyon National Park. It is possible that the generally lower survival rates observed at Sequoia/Kings Canyon may relate to local stressors acting on the breeding grounds which are affecting annual survival of adults. It is conceivable that higher levels of air pollution and airborne contaminants at Sequoia/Kings Canyon than at Yosemite could be driving these differences in annual survival observed between these two locations.

Causes of Population Change in Yosemite's Birds
Lower-than-expected productivity appeared to be driving or contributing to the population declines of seven of 11 declining species, Western Wood-Pewee, Dusky Flycatcher, Warbling Vireo, Hermit Thrush, Yellow Warbler, Chipping Sparrow, and Lazuli Bunting, while low survivorship also appeared to contribute to the declines of Dusky Flycatcher and Hermit Thrush. The population decline of only one species, Golden-crowned Kinglet, appeared to be driven by low survival. Similarly, higher than expected or increasing productivity appeared to be driving the population changes of all three increasing species, Mountain Chickadee, Yellow-rumped Warbler, and MacGillivray's Warbler, with higher survival also contributing to the increase in MacGillivray's Warbler. Thus, overall, it appeared that productivity at Yosemite is driving or influencing the population dynamics of ten of the 14 species that showed substantial trends, whereas survival only appeared to be driving or influencing trends in three species. This further indicates that the population dynamics of most of Yosemite's breeding species are being affected by conditions in Yosemite National Park and the Sierra Nevada.

Future Analyses
MAPS mark-recapture analyses currently do not permit the estimation of survival of first-year birds, because young birds typically disperse substantial distances to their site of first breeding, resulting in very few or no recaptures of birds banded as juveniles. In future analyses, using reverse symmetry modeling, we hope to estimate recruitment of first-year and older birds for species for which we can identify those age classes during the breeding season. This will allow us to make inferences regarding first-year survival rates for those species as well as amounts of immigration and emigration in their populations. We will then be able to examine patterns in adult and first-year survival rates according to geographic location, climate, and habitat considerations, and to identify causes of declines in species such as Hermit Warbler, Dark-eyed Junco, and Black-headed Grosbeak that do not show deficient productivity or adult survival rates at Yosemite and whose declines may be driven by low first-year survival or deficient recruitment. In addition, when we have 15 consecutive years of data from the long-running stations, we hope to be able to perform, at the spatial scale of the four individual stations, many of the analyses that are currently conducted on data from all stations combined, and thus provide further information on the effects of elevation on recruitment and population dynamics.

We have recently initiated additional broad-scale analyses to help us further understand the population dynamics of landbirds and potential management actions to assist bird populations.

First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to determine the proximate demographic causes of population trends within a species on continental, regional, and local spatial scales. Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area around each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well. These types of analyses provide extremely powerful tools to identify and formulate management actions aimed at reversing declining populations and maintaining stable or increasing populations of landbirds, because they can address the particular vital rate responsible for the decline. We plan to conduct similar analyses for the target species in the Sierra, by modeling productivity as a function of various landscape characteristics that vary along a gradient from the pristine landscapes found in Yosemite National Park to the much more heavily managed landscapes on Sierran national forests.

Indeed, one important objective of the MAPS Program in relatively pristine protected areas such as large national parks like Yosemite is to provide control data on the vital rates of landbirds in order to aid the identification of generalized management guidelines and the formulation of specific management actions that can be implemented to reverse the population declines of focal and priority landbird species and to maintain populations of stable or increasing species. The identification and formulation of these management guidelines and actions are to be achieved by modeling the vital rates (productivity, adult survival, first-year survival, and/or recruitment rates) of the various landbird species as a function of landscape-level and elevation-specific habitat characteristics along with spatially explicit weather variables. Management strategies will subsequently involve efforts to modify habitat characteristics from those associated with low productivity or recruitment to those associated with high productivity or recruitment (for species for which low productivity or recruitment is driving the population decline).

Because of the pronounced elevation factor at Yosemite, and the complex effects of weather on population size and productivity, we will need to incorporate elevation-specific habitat analyses and account for weather on an annual basis. Elevation effects on adult population size appear to reflect the effects of dry years (greater population sizes at higher elevations due to lack of snow pack and warmer temperatures) vs. wet years (greater population sizes at lower elevations due to higher levels of food resources and cooler temperatures). Thus, landscape-level analyses at Yosemite will necessarily involve interactions between elevation and weather as well as habitat characteristics. It is the complexity of these interactions that create the need for long-term data.

Conclusions

Analyses of 12 years of MAPS data from four stations along an elevation gradient in Yosemite National Park, plus seven years of data from a fifth station, have shown that bird populations in Yosemite have decreased significantly over the 12 years with substantially more species decreasing than increasing. We have also demonstrated how MAPS data can be used to measure and assess the effects of productivity and survivorship at different elevations as driving forces for the varying avian population trends documented in Yosemite National Park. Clearly, the indices and estimates of primary demographic parameters produced by the Yosemite MAPS Program are providing critical information that can be extremely useful for the management and conservation of landbirds in Yosemite and the Sierra Nevada and, in combination with similar data from other areas, across the whole of North America.

The results highlighted in this report reveal that population dynamics of the breeding birds of Yosemite National Park are complex, as are the likely causes of the dynamics and, for those trends deemed problematic, their solutions. This complexity, in turn, underscores the importance of standardized, long-term data. Once 15 years of data have accumulated and the precision of our estimates improves further, and both short- and long-term trends become more clearly established, we will be able to incorporate weather and climate data as well as landscape-level habitat data as additional co-variates in logistic regression analyses of productivity and in survivorship models. With these additional years of data we will be able to further our understanding of the population dynamics of Yosemite's birds and shed more light on the complex paths leading from environmental stressors to population responses.

We conclude that the MAPS protocol is very well-suited to provide a critical component of the National Park Service's Long-Term Ecological Monitoring program in Yosemite National Park. Based on the above information, we recommend that the operation of the five MAPS stations in Yosemite National Park be sustained into the future, and funding be sought for a comprehensive analysis of all Sierran MAPS data (including Yosemite's) to be conducted after 15 years of data have accumulated.

INTRODUCTION

The National Park Service (NPS) has been charged with the responsibility of managing natural resources on lands under its jurisdiction in a manner that conserves them unimpaired for future generations. In order to carry out this charge, the NPS is implementing integrated long-term programs for inventorying and monitoring the natural resources in national parks and other NPS units. To accomplish these objectives, a pilot study to develop and evaluate field and analytical techniques was first implemented in four national parks across the United States. The goals of this pilot program were to develop: (1) quantitative sampling and analytical methods that can provide relatively complete inventories and long-term trends for many components of biological diversity; and (2) effective means of monitoring the ecological processes driving the trends (Van Horn et al. 1992). An additional goal was that methods evaluated be useful in other national parks across the United States. This program is referred to as a Long-term Ecological Monitoring (LTEM) Program.

The development of an effective long-term ecological monitoring program in the national parks can be of even wider importance than aiding the NPS in managing its resources. Because lands managed by the NPS provide large areas of relatively pristine ecosystems, that promise to be maintained in a relatively undisturbed manner indefinitely into the future, studies conducted in national parks can provide invaluable information for monitoring natural ecological processes and for evaluating the effects of large-scale, even global, environmental changes. The national parks and other NPS units can also serve as critical control areas for monitoring the effects of relatively local land-use practices. Thus, long-term monitoring data from the national parks can provide information that is crucial for efforts to preserve natural resources and biodiversity at multiple spatial scales, ranging from the local scale to the continental or even global scale.

Landbirds

Landbirds, because of their high body temperature, rapid metabolism, and high ecological position on most food webs, may be excellent indicators of the effects of local, regional, and global environmental change on terrestrial ecosystems. Furthermore, their abundance and diversity in virtually all terrestrial habitats, diurnal nature, discrete reproductive seasonality, and intermediate longevity facilitate the monitoring of their population and demographic parameters. It is not surprising, therefore, that landbirds have been selected by the NPS to receive high priority for monitoring. Nor is it surprising that several large-scale monitoring programs that provide annual population estimates and long-term population trends for landbirds are already in place on this continent. They include the North American Breeding Bird Survey (BBS), the Breeding Bird Census, the Winter Bird Population Study, and the Christmas Bird Count.

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest-, scrubland-, and grassland-inhabiting species, appear to be in serious decline (Peterjohn et al. 1995). Indeed, populations of most landbird species appear to be declining on a global basis. Nearctic-Neotropical migratory landbirds (species that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al.1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). A major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. As one of the major cooperating agencies in PIF, the NPS has defined its role in the program to include the establishment of long-term monitoring programs at NPS units using protocols developed by the Monitoring Working Group of PIF. Clearly, the long-term ecological monitoring goals of the NPS and the monitoring and research goals of PIF share many common elements.

The goals of these programs differ, however, in at least one important respect. A major goal of PIF is to reverse population declines, especially in rare or uncommon (although not threatened or endangered) species, while a major objective of the NPS's LTEM program is to understand the ecological processes driving population changes. This latter goal often necessitates concentrating on relatively common or even abundant species that are undergoing population changes, rather than rare or uncommon ones. Thus, appropriate target species might be expected to differ somewhat between PIF and LTEM efforts.

Primary Demographic Parameters

Existing population-trend data on Neotropical migrants, while suggesting severe and sometimes accelerating declines, provide no information on primary demographic parameters (productivity and survivorship) of these birds. Thus, population-trend data alone provide no means for determining at what point(s) in the life cycles problems are occurring, or to what extent the observed population trends are being driven by causal factors that affect birth rates, death rates, or both (DeSante 1995). In particular, large-scale North American avian monitoring programs that provide only population-trend data have been unable to determine to what extent forest fragmentation and deforestation on the temperate breeding grounds, versus that on the tropical wintering grounds, are causes for declining populations of Neotropical migrants. Without critical data on productivity and survivorship, it will be extremely difficult to identify effective management and conservation actions to reverse current population declines (DeSante 1992).

The ability to monitor primary demographic parameters of target species must also be an important component of any successful long-term inventory and monitoring program that aims to monitor the ecological processes leading from environmental stressors to population responses (DeSante and Rosenberg 1998). This is because environmental factors and management actions generally affect primary demographic parameters directly and these effects usually can be observed over a short time period (Temple and Wiens 1989). Because of the buffering effects of floater individuals and density-dependent responses of populations, there may be substantial timelags between changes in primary parameters and resulting changes in population size or density as measured by census or survey methods (DeSante and George 1994). Thus, a population could be in trouble long before this becomes evident from survey data. Moreover, because of the vagility of many animal species, especially birds, local variations in secondary parameters (e.g., population size or density) may be masked by recruitment from a wider region (George et al. 1992) or accentuated by lack of recruitment from a wider area (DeSante 1990). A successful monitoring program should be able to account for these factors.

Lastly, a successful monitoring program should be able to detect significant differences in productivity as a function of such local variables as landscape-level habitat characteristics or degree of habitat disturbance. The detection of such differences can lead to immediate management implementation within a national park, especially for species where long-term demographic monitoring suggests that declines are related to local (e.g., productivity) rather than remote (e.g., overwintering survival in Neotropical migrants) factors.

MAPS

In 1989, The Institute for Bird Populations (IBP) established the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public agencies, private organizations, and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations providing long-term demographic data on landbirds (DeSante et al. 1995). The design of the MAPS program was patterned after the very successful British Constant Effort Sites (CES) Scheme that has been operated by the British Trust for Ornithology since 1981 (Peach et al. 1996). The MAPS program was endorsed in 1991 by both the Monitoring Working Group of PIF and the USDI Bird Banding Laboratory, and a four-year pilot project (1992-1995) was approved by the USDI Fish and Wildlife Service and National Biological Service (now the Biological Resources Division [BRD] of the U.S. Geological Survey [USGS]) to evaluate its utility and effectiveness for monitoring demographic parameters of landbirds. A peer review of the program and of the evaluation of the pilot project was completed by a panel assembled by USGS/BRD (Geissler 1996). The review concluded that: (1) MAPS is technically sound and is based on the best available biological and statistical methods; and (2) it complements other landbird monitoring programs such as the BBS by providing useful information on landbird demographics that is not available elsewhere.

Now in its 16th year (13th year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to nearly 500 stations in 2004. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies in PIF, including the NPS, USDA Forest Service, US Fish and Wildlife Service, Department of Defense, Department of the Navy, and Texas Army National Guard. Within the past 12 years, IBP has been contracted to operate five MAPS stations in Yosemite National Park, as well as six in Denali, five in Shenandoah, and two in Kings Canyon national parks, and six on Cape Cod National Seashore.

Goals and Objectives of MAPS

MAPS is organized to fulfill three tiers of goals and objectives: monitoring, research, and management.

I. The specific monitoring goals of MAPS are, for over 100 target species, including Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents, to provide:

   (A) annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and

(B) annual estimates of adult population size, adult survival rates, proportions of residents among newly captured adults, recruitment rates into the adult population, and population growth rates from modified Cormack-Jolly-Seber analyses of mark-recapture data on adult birds.

II. The specific research goals of MAPS are to identify and describe:

(A) temporal and spatial patterns in these demographic indices and estimates at a variety of spatial scales ranging from the local landscape to the entire continent; and

(B) relationships between these patterns and ecological characteristics of the target species, population trends of the target species, station-specific and landscape-level habitat characteristics, and spatially-explicit weather variables.

III. The specific management goals of MAPS are to use these patterns and relationships, at the appropriate spatial scales, to:

(A) identify thresholds and trigger points to notify appropriate agencies and organizations of the need for further research and/or management actions;

(B) determine the proximate demographic cause(s) of population change;

(C) suggest management actions and conservation strategies to reverse population declines and maintain stable or increasing populations; and

(D) evaluate the effectiveness of the management actions and conservation strategies actually implemented through an adaptive management framework.

The overall objectives of MAPS are to achieve the above-outlined goals by means of long-term monitoring at two major spatial scales. The first is a very large scale, effectively the entire North American continent divided into eight geographic regions. It is envisioned that the national parks, along with national forests, military installations, and other publicly owned lands, will provide a major subset of sites for this large-scale objective.

The second, smaller-scale but still long-term objective is to fulfill the above-outlined goals for specific geographic areas (perhaps based on BBS physiographic strata, such as the Sierra Nevada, Cascade Mountains, Central Valley, or California Foothills, or the newly described Bird Conservation Regions) or specific locations (such as individual national parks, national forests, or military installations). The objective for MAPS at these smaller scales is to aid research and management efforts within the areas, parks, forests, or installations to protect and enhance their avifauna and ecological integrity. The sampling strategy utilized at these smaller scales should be hypothesis-driven and should be integrated with other research and monitoring efforts.

Both long-term objectives are in agreement with goals laid out for the NPS's Long-Term Ecological Monitoring Program. Accordingly, the operation of MAPS stations at Yosemite

National Park has been included in the development of a LTEM Program for the Park. It is expected that information from the MAPS program will be capable of aiding research and management efforts within Yosemite National Park to protect and enhance the Park's avifauna and ecological integrity.

Recent Important Results from MAPS

Recent important results from MAPS reported in the peer-reviewed literature include the following: (1) Age ratios obtained during late summer, population-wide mist netting provided a good index to actual productivity in the Kirtland's Warbler (Bart et al. 1999). (2) Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante et al. 1999). (3) Patterns of productivity from MAPS at two large spatial scales (eastern North America and the Sierra Nevada) not only agreed with those found by direct nest monitoring and those predicted from theoretical considerations, but were in general agreement with current life-history theory and were robust with respect to both time and space (DeSante 2000). (4) Modeling spatial variation in MAPS productivity indices and survival-rate estimates as a function of spatial variation in population trends provides a successful means for identifying the proximate demographic cause(s) of population change at multiple spatial scales (DeSante et al. 2001). (5) Productivity of landbirds breeding in Pacific Northwest national forests is affected by global climate cycles including the El Niño Southern Oscillation and the North Atlantic Oscillation, in such a manner that productivity of Neotropical migratory species is determined more by late winter and early spring weather conditions on their wintering grounds than by late spring and summer weather conditions on their breeding grounds (Nott et al. 2002). (6) Analyses describing relationships between four demographic parameters (adult population size, population trend, number of young, and productivity) and landscape-level habitat characteristics for bird species of conservation concern have been completed for 13 military installations in south-central and southeastern United States, allowing conservation management strategies to be formulated and tested (Nott et al. 2003a). (7) Analyses describing relationships between demographic parameters and landscape-level habitat characteristics for bird species of conservation concern have also been completed for 21 species inhabiting six Region-6 and one Region-1 National Forests in Washington, Oregon, and Montana (Nott et al. 2005). Most or all of these reports are available in downloadable format at the Institute for Bird Populations website: http://www.birdpop.org/publications.htm. These results indicate that MAPS is capable of achieving, and in some cases is already achieving, its objectives and goals.

The 2004 Report on the Yosemite MAPS Program

In this report we summarize results of the MAPS program at five stations in Yosemite National Park from 1993 (1998 at Gin Flat East Meadow and additionally from 1990 at the Hodgdon Meadow station) through 2004. We present annual changes in the numbers of adult and young birds and in reproductive indices between 2003 and 2004, 12-year (7-year at Gin Flat East) mean indices of adult population size and productivity at each individual station and for all stations combined for each species and for all species pooled. For selected target species and all species pooled, we present temporal trends in adult population size at each station and for all stations combined and productivity trends for all stations combined. We use mark-recapture models to provide estimates of annual adult apparent survival rate, recapture probability, and proportion of residents among newly captured adults for most of the target species. Finally, we model productivity and survivorship as a function of body mass, and consider all values, relationships, and trends in these vital rates in order to suggest proximate demographic causes of the population trends observed in Yosemite's and the Sierra Nevada's birds.

METHODS

Establishment and Operation of Stations

Five MAPS stations were re-established and operated in Yosemite National Park in 2004, at the same locations they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were as follows: 1) White Wolf Meadow, set in a wet montane meadow with red fir/lodgepole pine forest at 2402 m elevation; 2) Gin Flat East Meadow, located in a wet montane meadow with mixed red fir and lodgepole pine at 2073 m elevation; 3) Crane Flat Meadow, located in a wet montane meadow with willow/aspen thickets and mixed coniferous forest at 1875 m elevation; 4) Hodgdon Meadow, located in a wet montane meadow with willow/dogwood thickets, mixed coniferous forest, and a patch of California Black Oak woodland at 1408 m elevation; and 5) Big Meadow, located in riparian willows and mixed coniferous forest in an open dry meadow at 1311 m elevation. The Hodgdon Meadow station was established and first operated in 1990, the Gin Flat East Meadow station in 1998, and the other three stations in 1993. See Table 1 for details of habitats and operation of each station in 2004.

Through the efforts of three intensively trained field biologist interns of The Institute for Bird Populations, Caleb Ashling, Keith Doran, and Alejandro Solano, trained and supervised by IBP staff field biologists Sara Martin and Denise Jones, these five MAPS banding stations were operated during 2004 (and in all preceding years) in accordance with the highly standardized banding protocols developed for the MAPS Program throughout North America (DeSante et al. 2004a).

A total of ten net sites (14 at the Hodgdon Meadow station) were re-established at each of the stations in 2004 at the exact same locations where they were established and operated in each of the preceding years. One 12-m-long, 30-mm-mesh, nylon mist net was erected at each of the ten net sites at four of the stations on each day of operation. At Hodgdon Meadow, seven of the 14 net sites were operated on one day with the remaining seven net sites operated on a second day. Each of the stations was operated for six morning hours per day (beginning at about local sunrise) during one day (two days for Hodgdon Meadow) in each of eight consecutive 10-day periods between May 21 and August 8 or, for the two higher-elevation stations (White Wolf and Gin Flat East), for one day in each of seven consecutive 10-day periods between May 31 and August 8. With very few exceptions, the operation of all stations occurred on schedule in 2004 during each of the ten-day periods. A brief overview of both the field and analytical techniques used in 2004 is presented here.

Data Collection

With few exceptions, all birds captured during the course of the study were identified to species, age, and sex and, if unbanded, were banded with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be comprised. Such situations involved exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as high winds or rainfall. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms (DeSante et al. 2004a):

(1) capture code (newly banded, recaptured, band changed, unbanded);
(2) band number;
(3) species;
(4) age and how aged;
(5) sex (if possible) and how sexed (if applicable);
(6) extent of skull pneumaticization;
(7) breeding condition of adults (i.e., extent of cloacal protuberance or brood patch);
(8) extent of juvenal plumage in young birds;
(9) extent of body and flight-feather molt;
(10) extent of primary-feather wear;
(11) presence of molt limits and plumage characteristics;
(12) wing chord;
(13) fat class and body mass;
(14) date and time of capture (net-run time);
(15) station and net site where captured; and
(16) any pertinent notes.

Effort data, i.e., the number and timing of net-hours on each day (period) of operation, were also collected in a standardized manner. In order to allow constant-effort comparisons of data to be made, the times of opening and closing the array of mist nets and of beginning each net check were recorded to the nearest ten minutes. The breeding (summer residency) status (confirmed breeder, likely breeder, non-breeder) of each species seen, heard, or captured at each MAPS station on each day of operation was recorded using techniques similar to those employed for breeding bird atlas projects.

For each of the five stations operated, simple habitat maps were prepared on which up to four major habitat types, as well as the locations of all structures, roads, trails, and streams, were identified and delineated; when suitable maps from previous years were available, these were updated. The pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover), in each major habitat type, were classified into one of twelve pattern types and eleven cover categories according to guidelines spelled out in the MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, Philip Nott (Nott et al. 2003b).

Computer Data Entry and Verification

The computer entry of all banding data was completed by John W. Shipman of Zoological Data Processing, Socorro, NM. The critical data for each banding record (capture code, band number, species, age, sex, date, capture time, station, and net number) were proofed by hand against the raw data and any computer-entry errors were corrected. Computer entry of effort and vegetation data was completed by IBP biologists using specially designed data entry programs. All banding data were then run through a series of verification programs as follows:

(1) Clean-up programs to check the validity of all codes entered and the ranges of all numerical data;

(2) Cross-check programs to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data;
(3) Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage;
(4) Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species; and
(5) Verification programs to screen banding and recapture data from all years of operation for inconsistent species, age, or sex determinations for each band number.

Any discrepancies or suspicious data identified by any of these programs were examined manually and corrected if necessary. Wing chord, weight, station of capture, date, and any pertinent notes were used as supplementary information for the correct determination of species, age, and sex in all of these verification processes.

Data Analysis
To facilitate analyses, we first classified the landbird species captured in mist nets into five groups based upon their breeding or summer residency status. Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during all years* that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated; a transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species; an altitudinal disperser (A) if the species breeds only at lower elevation than that of the station but disperses to higher elevations after breeding; and a migrant (M) if the station was not located within the overall breeding range of the species. Data for a given species from a given station were included in productivity analyses if the station was within the breeding range of the species; that is, data were included from stations where the species was a breeder (B, U, or O), transient (T), or altitudinal disperser (A), but not where the species was a migrant (M). Data for a given species from a given station were included in trend and survivorship analyses only if the species was classified as a regular (B) or usual (U) breeder at the station. Throughout this report we define "target species" for trend and survivorship analyses as those for which an average of 2.5 individual adult birds were captured per year at all stations combined or at each station for station-specific analysis. For the four long-running stations combined, a total of 38 species met this requirement and are termed target species. For survivorship analyses, an additional requirement for including a target species in the analysis was that at least two returns were recorded at all stations combined.

A. Population-size and productivity analyses. The proofed, verified, and corrected banding data from 2004 were run through a series of analysis programs that calculated for each species and for all species combined at each station and for all stations pooled:

(1) the numbers of newly banded birds, recaptured birds, and birds released unbanded;

(2) the numbers and capture rates (per 600 net-hours) of first captures (in 2004) of individual adult and young birds; and
(3) the reproductive index.

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), the number of adult birds captured was used as an index of adult population size. As our index of post-fledging productivity we are now using "reproductive index" (number of young divided by number of adults) as opposed to "proportion of young in the catch" previously used. Reproductive index is a more intuitive value for productivity, and it is also more comparable to other calculated MAPS parameters such as recruitment indices.

For all six stations we calculated changes between 2003 and 2004 in the numbers of adult and young birds captured and in the indices of post-fledging productivity. We determined the statistical significance of any changes that occurred according to methods developed by the BTO in their CES scheme (Peach et al. 1996). These year-to-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by-period basis. We excluded captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year. For species captured at several stations in Yosemite National Park, the significance of park-wide annual changes in the numbers of adult and young birds and in the indices post-fledging productivity was inferred statistically using confidence intervals derived from the standard errors of the mean percentage changes. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance and we use the term "near-significant" or "nearly significant" for differences for which $0.05 \leq P < 0.10$.

B. Analyses of trends in adult population size and productivity. For each target species and for all species pooled we examined multi-year trends (7-year trends at Gin Flat East Meadow, 12-year trends at the other four stations and for all four stations combined, and additional 15-year trends at Hodgdon Meadow) in indices of adult population size, and 12-year trends (for all-four long-running stations combined) in productivity indices. For trends in adult population size, we first calculated adult population indices for each species for each of the 12 years based on an arbitrary starting index of 1.0 in the first year of station operation (1998 at Gin Flat East Meadow, 1993 at the other four stations and for all stations combined and, additionally, 1990 at Hodgdon Meadow). Constant-effort changes (as defined above) were used to calculate these "chain" indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

$$PSI_{i+1} = PSI_i + PSI_i * (d_i/100),$$

where PSI_i is the population size index for year i and d_i is the percentage change in constant-effort numbers from year i to year i+1. A regression analysis was then run to determine the slope (*PT*) of these indices. Because the indices for adult population size are based on percentage changes, we further calculated the annual percent change (*APC*), defined as the average change per year, to provide an estimate of the population trend for the species; *APC* was calculated as:

(actual year-one value of *PSI* / predicted year-one value of *PSI* based on the regression) * *PT*.

We present the *APC*, the standard error of the slope (*SE*), the correlation coefficient (*r*), and the significant of the correlation (*P*) to describe each trend. For 12-year trends, species for which $r \geq 0.30$ are considered to have a substantially increasing trend, those for which $r \leq -0.3$ are considered to have a substantially decreasing trend, those for which absolute $r < 0.3$ and $SE \leq 0.029$ are considered to have a non-substantial and non-fluctuating trend, and those for which absolute $r \leq 0.3$ and $SE > 0.029$ are considered to have non-substantial, widely fluctuating trends. Cut-off values for substantial and fluctuating trends vary by number of years of data: the cut-off for *r* is 0.50 and that for *SE* is 0.071 for seven-year trends (at the Gin Flat East station), and the cut-off for *r* remains 0.30 and that for *SE* is 0.020 for 15-year trends (at the Hodgdon Meadow station).

Trends in Productivity, *PrT*, for all stations combined were calculated in an analogous manner by starting with actual productivity values in 1993 and calculating each successive year's value based on the actual constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r*), and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that, for non-substantial trends, we do not attempt to distinguish between those that are widely fluctuating and those that are non-fluctuating.

C. Survivorship analyses – Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) were conducted on the target species using 12 years (1993-2004) of capture histories of adult birds. Using the computer program TMSURVIV (White 1983, Hines et al. 2003), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (ϕ), adult recapture probability (p), and the proportion of residents among newly captured adults (τ) using a between- and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002, Hines et al. 2003). The use of the transient model ($\phi p \tau$) accounts for the existence of transient adults (dispersing and floater individuals which are only captured once) in the sample of newly captured birds, and provides survival estimates that are unbiased with respect to these transient individuals (Pradel et al. 1997). Recapture probability is defined as the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded.

The 12 years of data, 1993-2004, allowed us to consider all possible combinations of both time-constant and time-dependent models for each of the three parameters estimated from the transient model, for a total of eight models. We limited our consideration to models that produced estimates for both survival and recapture probability that were neither 0 nor 1. The goodness of fit of the models was tested by using a Pearson's goodness-of-fit test. Of those models that fit the data, the one that produced the lowest Akaike Information Criterion, correcting for dispersion of data and for use with smaller sample sizes relative to the number of parameters examined ($QAIC_C$), was chosen as the optimal model (Burnham et al. 1995). Models showing $QAIC_C$'s within 2.0 $QAIC_C$ units of each other were considered effectively equivalent (Anderson and Burnham 1999). The $QAIC_C$ was calculated by multiplying the log-likelihood for the given model by -2, adding two times the number of estimable parameters in the model, and providing corrections for overdispersed data and small sample sizes.

To assess the degree of annual variation in survival for each species, we calculated $\Delta QAIC_C$ as the difference between the completely time-constant model ($\phi p \tau$) and the model with time-dependent survival but time-constant capture probability and proportion of residents ($\phi_t p \tau$); thus, $\Delta QAIC_C$ was calculated as $QAIC_C(\phi_t p \tau)$-$QAIC_C(\phi p \tau)$, with lower (or more negative) $\Delta QAIC_C$ values indicating stronger interannual variation in survival.

D. Analyses of productivity and survival as a function of mean body mass. In birds, both productivity and survival vary with body mass: on average, the larger the bird the lower the annual productivity and the higher the annual survival. Thus, in order to assess whether or not annual productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. We regressed both mean productivity indices and time-constant survival-rate estimates against body mass (log transformed to normalize the values) for all target species at the four long-running stations combined, and compared productivity indices and survival-rate estimates for individual species to the regression lines produced by these fits. We used the log of mean body mass values given by Dunning (1993). In this way we attempted to assess whether or not productivity and survival of a given species at Yosemite was as expected, lower than expected, or higher than expected based on its body mass.

RESULTS

A total of 2207.2 net-hours was accumulated at the five MAPS stations operated in Yosemite National Park in 2004 (Table 1). Data from 1958.5 of these net-hours could be compared directly to the previous year's data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2004 values. The 2004 capture summary of the numbers of newly-banded, unbanded, and recaptured birds in Yosemite National Park is presented for each species at each of the five stations individually and for all stations combined in Table 2. A total of 2644 captures of 66 species was recorded during the summer of 2004. Newly banded birds comprised 75.2% of the total captures. The greatest number of total captures (720) was recorded at the Crane Flat station and the smallest number of total captures (212) was recorded at the White Wolf station. The highest species richness occurred at Hodgdon Meadow and Big meadow (46 species each) and the lowest species richness occurred at White Wolf (28 species).

The 2004 capture rates (per 600 net-hours) of individual adult and young birds and the 2004 reproductive index (number of young per adult) are presented for each species and for all species pooled at each station and all stations combined in Table 3. We present capture rates (captures per 600 net-hours) of adults and young in this table so that the data can be compared among stations which, because of the vagaries of weather and accidental net damage, can differ from one another in effort expended (see Table 1). These capture indices suggest that the total adult population size in 2004 was greatest at Crane Flat, followed in descending order by Gin Flat East Meadow, Hodgdon Meadow, Big Meadow, and White Wolf (Table 3). The capture rate of young of all species pooled at each station in 2004 was highest at Gin Flat East Meadow, followed by Crane Flat, Hodgdon Meadow, Big Meadow, and White Wolf (Table 3). Reproductive index (the number of young per adult) at the five stations in 2004 was greatest at Gin Flat East Meadow (1.58), followed by Crane Flat (1.28), Big Meadow (1.28), Hodgdon Meadow (0.92), and White Wolf (0.58).

Among individual species in 2004, Orange-crowned Warbler was the most frequently captured, followed by Dark-eyed Junco, Yellow-rumped Warbler, Lincoln's Sparrow, MacGillivray's Warbler, Nashville Warbler, Hermit Warbler, Warbling Vireo, Anna's Hummingbird, Red-breasted Sapsucker, Black-headed Grosbeak, and House Wren (Table 2). Overall, the most abundant breeding species at the five Yosemite National Park MAPS stations in 2004 (as determined by the number of adults captured per 600 net-hours), in decreasing order, were Dark-eyed Junco (37.8), Lincoln's Sparrow (20.4), MacGillivray's Warbler (18.5), Yellow-rumped Warbler (16.6), Warbling Vireo (10.9), Red-breasted Sapsucker (6.8), Hermit Warbler (6.8), and Song Sparrow (6.8). The following is a list of the common breeding species (captured at a rate of at least 6.0 adults per 600 net-hours), in decreasing order, at each station in 2004 (Table 3):

White Wolf
Dark-eyed Junco
Yellow-rumped Warbler
Lincoln's Sparrow

Hodgdon Meadow
MacGillivray's Warbler
Song Sparrow
Warbling Vireo
Dark-eyed Junco
Red-breasted Sapsucker
Lincoln's Sparrow
Black-headed Grosbeak
"Western" Flycatcher
Hermit Warbler
American Robin

Gin Flat East Meadow
Lincoln's Sparrow
Yellow-rumped Warbler
Dark-eyed Junco
Mountain Chickadee
Pine Siskin
MacGillivray's Warbler
Dusky Flycatcher
Hermit Warbler
Western Tanager

Big Meadow
Bushtit
Nashville Warbler
Yellow Warbler
Spotted Towhee

Crane Flat
Dark-eyed Junco
Lincoln's Sparrow
Yellow-rumped Warbler
MacGillivray's Warbler
Warbling Vireo
Hermit Warbler
Dusky Flycatcher
"Western" Flycacther
Golden-crowned Kinglet

B. Comparisons between 2003 and 2004. Constant-effort comparisons between 2003 and 2004 were undertaken at all five Yosemite National Park MAPS stations for numbers of adult birds captured (adult population size; Table 4), numbers of young birds captured (Table 5), and reproductive index (numbers of young per adult; Table 6).

Adult population size for all species pooled for all five stations combined showed a fairly substantial but non-significant increase between 2003 and 2004, of +10.7% (Table 4). Twenty-two of 56 species showed increases, a proportion not significantly greater than 0.50. The change in adult population size for all species pooled showed increases at four of the five stations, by amounts ranging from +0.6% at Hodgdon Meadow to +33.1% at Gin Flat East Meadow, but decreased at Big Meadow by -21.9%. The proportion of decreasing or increasing species was not significant at any station. Significant or near-significant increases in the number of adults captured, for all stations combined, were recorded for two species, Yellow-rumped Warbler and Dark-eyed Junco, whereas five species, Hermit Thrush, Western Tanager, Chipping Sparrow, Lazuli Bunting, and Purple Finch showed such decreases.

The number of young birds captured of all species pooled at all five stations in Yosemite National Park combined showed a highly significant increase, of +136.4% between 2003 and 2004 (Table 5). Increases were recorded for 38 of 53 species, a proportion highly significantly greater than 0.50 (P = 0.001). Increases were recorded at all five stations, by amounts ranging from +97.7% at Hodgdon Meadow to +425.0% at White Wolf . Significant or near-significant proportions of increasing species were recorded at all five stations (Table 5). Three species (Yellow-rumped Warbler, Lincoln's Sparrow, and Dark-eyed Junco) showed significant increases in numbers of young captured across all stations, whereas no species showed a significant or near-significant decrease.

Productivity (the reproductive index or number of young per adult) of all species pooled at all stations combined in 2004 (1.198) increased from that in 2003 (0.561) by a significant absolute value of +0.637 (Table 6). Thirty-one of 44 species increased, a proportion highly significantly greater than 0.50 (*P* = 0.005). Productivity increased at all five stations, ranging from +0.464 at White Wolf to +0.917 at Big Meadow. The proportion of increasing species was nearly significant at Crane Flat. Three species (White-headed Woodpecker, Hermit Warbler, and Lazuli Bunting) showed significant or near-significant increases in productivity across stations, whereas no species showed such decreases (Table 6).

Thus, breeding populations tended to increase in 2004 as compared with those of 2003 at all stations except Big Meadow, while productivity showed significant, park-wide increases. These are opposite to the changes observed between 2002 and 2003. The increases in breeding population sizes tended to be greater at higher-elevation stations, while the large increases in productivity were relatively uniform across elevations. Changes in productivity (but not breeding populations) were also species-wide. As in past years we suspect that variations caused by local climate and snowpack have been a factor in these changes, although in 2004 these factors appeared to affect productivity irrespective of elevation.

Mean Indices of Adult Population Size and Productivity
Table 7 presents mean annual numbers (per 600 net-hours) of individual adult and young birds captured, and proportions of young in the catch during a) the 12-year period (1993-2004) at White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow, as well as all stations combined, b) the seven-year period (1998-2004) for the Gin Flat East Meadow station, and c) the 15-year period (1990-2004) for Hodgdon Meadow. The all-species-pooled values at the bottom of the table indicate that the highest breeding populations at Yosemite occurred at the mid-elevation Crane Flat Meadow station, followed in descending order by Hodgdon Meadow, Big Meadow, Gin Flat East Meadow, and White Wolf. The 12-year mean at Hodgdon Meadow was higher than the 15-year mean there by 14%, indicating lower-than-average adult population sizes there during 1990-1992.

Numbers of young captured followed a different sequence, being highest at Gin Flat East Meadow, followed by Crane Flat, Hodgdon Meadow, Big Meadow, and White Wolf. Productivity was highest at Gin Flat East, followed by White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow. Productivity at Hodgdon Meadow was slightly higher during the 12-year period (0.66) than during the 15-year period (0.63). Species richness of adults followed yet a different sequence, being highest at Big Meadow, the lowest elevation station, followed by Hodgdon Meadow, Crane Flat, Gin Flat East Meadow, and White Wolf. The most abundant breeding species at MAPS stations in Yosemite over the 12-year period, having overall capture rates greater than 6.0 adults per 600 net-hours, were, in descending order: Dark-eyed Junco, MacGillivray's Warbler, Yellow-rumped Warbler, Lincoln's Sparrow, Warbling Vireo, Dusky Flycatcher, Lazuli Bunting, Song Sparrow, Hermit Warbler, Purple Finch, and Black-headed Grosbeak. Overall, total species richness was 75 species, while the 12-year mean number of adults captured per 600 net-hours was 214.5 and the mean reproductive index was 0.76.

Multi-year Trends in Adult Population Size and Productivity
"Chain" indices of adult population size are presented for target species and for all species pooled, at each of the five stations individually and for the four long-running stations combined,

in Figures 1-7. For the four stations combined (Fig. 1), White Wolf (Fig. 2), Crane Flat (Fig. 3), Hodgdon Meadow (Fig. 4), and Big Meadow (Fig. 6) we show 12-year trends (1993-2004); for Gin Flat East Meadow (Fig. 7) we show seven-year trends (1998-2004); and for Hodgdon Meadow we also show 15-year trends (1990-2004; Fig. 5). We used annual percent change (*APC*) for each species as an estimate of the mean annual population trend for that species. These estimates of *APC*, along with the standard error of the slope (in parentheses), the correlation coefficient (r), and the significance of the correlation (P), are included for each target species and for all species pooled on each graph.

Twelve-year (1993-2004) population trends for 28 of the 33 target species and for all species pooled at the four long-running stations combined (all but Gin Flat East) are shown in Figure 1. Population trends for the four long-running stations combined could not be calculated for Williamson's Sapsucker, Hairy Woodpecker, Northern Flicker, "Western" Flycatcher, Black Phoebe, Red-breasted Nuthatch, Nashville warbler, Wilson's Warbler, Spotted Towhee, and Brewer's Blackbird because the adult population size index was zero during one or more of the 12 years. Populations of 13 species as well as all species pooled showed substantial declining trends ($r \leq -0.3$ for a 12-year trend). Substantial declines for Dusky Flycatcher, Black-headed Grosbeak, Lazuli Bunting, and all species pooled were highly significant; those for Western Wood-Pewee, Golden-crowned Kinglet, Yellow Warbler, Hermit Warbler, and Chipping Sparrow were significant; those for Lincoln's Sparrow and Purple Finch were nearly significant; and those for Hammond's Flycatcher, Warbling Vireo, and Hermit Thrush were not significant. In contrast, populations of only three species, (Mountain Chickadee, Yellow-rumped Warbler, and MacGillivray's Warbler) showed substantial increasing trends ($r \geq 0.3$), which were marginally significant for Yellow-rumped Warbler and not significant for the other two species. Populations of 12 species showed non-substantial trends (absolute $r < 0.3$), those of Red-breasted Sapsucker, Song Sparrow, and Dark-eyed Junco being non-fluctuating (SE of the slope ≤ 0.029) and those of Cassin's Vireo, Brown Creeper, House Wren, American Robin, Western Tanager, Red-winged Blackbird, Cassin's Finch, Pine Siskin, and Lesser Goldfinch showing wide interannual fluctuation (SE of the slope > 0.029). Overall, 19 of the 28 species showed negative trends. The 12-year trend for all species pooled represented a substantial and highly significant ($P = 0.001$) decrease of -2.7% per year, suggesting that total populations of landbirds in Yosemite have been reduced by 28% over the 12-year period (1993-2004).

At White Wolf (Fig. 2), populations of Dark-eyed Junco showed a substantial but non-significant positive 12-year trend whereas those of Yellow-rumped Warbler and all species pooled showed non-substantial and highly-fluctuating trends. Trends of both target species were positive whereas that of all species pooled was negative and indicated an annual decrease of -1.8% per year. At Crane Flat (Fig. 3), 12-year population trends for six species as well as all species pooled were substantially negative. These declines were significant for Warbling Vireo, Golden-crowned Kinglet, and Hermit Warbler; nearly significant for Brown Creeper and Lazuli Bunting; and not significant for Dusky Flycatcher and all species pooled. The population of only one species, Yellow-rumped Warbler, was substantially and near-significantly positive. Overall, nine of 11 species showed negative trends and that of all species pooled showed an annual decline of -1.8%. At Hodgdon Meadow (Fig. 4), 12-year population trends for five species as well as all species pooled were substantially negative. These declines were highly significant for

Dusky Flycatcher; significant for Lincoln's Sparrow; nearly significant for Chipping Sparrow, Purple Finch, and all species pooled; and not significant for Red-breasted Sapsucker. Population trends for three species (Western Wood-Pewee, Yellow-rumped Warbler, and Song Sparrow) were substantially positive, significantly so for Yellow-rumped Warbler and Song Sparrow. Trends for nine of the 17 target species were negative and that of all species pooled indicated a decline of -1.4% per year. At Big Meadow (Fig. 6), populations for three species (Song Sparrow, Black-headed Grosbeak, Lazuli Bunting) and all species pooled showed substantial and highly significant negative trends, whereas one species (Purple Finch) showed a substantial but non-significant positive trend. Five of the seven target species showed negative trends and the trend for all species pooled indicated a highly significant decrease of -5.9% per year.

At Hodgdon Meadow, 15-year trends (Fig. 5) were more positive (or less negative) than 12-year trends for 12 of the 15 species and all species pooled. Only Western Wood-Pewee, Yellow-rumped Warbler, and Purple Finch had less positive or more negative 15-year than 12-year trends. These patterns indicate that population sizes for most species at Hodgdon Meadow in 1990-1992 were lower than what would be expected from the subsequent 12-year trend, as also observed when comparing means (Table 7). The 15-year trend for all species pooled at Hodgdon Meadow indicated a non-substantial and non-significant increase of 0.4% per year.

At Gin Flat East Meadow (Fig. 7), trends were only available for the seven years, 1998-2004, and thus cannot be compared with the 12-year trends from other stations. Here, six of nine species as well as all species pooled showed substantial positive trends, with Lincoln's Sparrow and all species pooled being significant; American Robin being nearly significant; and Red-breasted Sapsucker, Mountain Chickadee, Western Tanager, and Dark-eyed Junco being non-significant; no trends were substantially negative and only one trend (Yellow-rumped Warbler) was slightly negative. Populations of all species pooled increased by 10.9% per year.

"Chain" indices of productivity for each of the 12 years (1993-2004) are shown in Figure 8 for 28 target species and all species pooled at the four long-running stations combined (all but Gin Flat East). Nine species (Western Wood-Pewee, Dusky Flycatcher, Cassin's Vireo, Brown Creeper, Hermit Thrush, Chipping Sparrow, Dark-eyed Junco, Cassin's Finch, and Lesser Goldfinch) showed substantially declining productivity trends ($r \leq -0.30$), which were nearly significant for Hermit Thrush and highly significant for Lesser Goldfinch. Twelve species as well as all species pooled showed substantially increasing productivity trends ($r \geq 0.30$); these were highly significant for Yellow Warbler and Black-headed Grosbeak; significant for Red-breasted Sapsucker, American Robin, Lincoln's Sparrow, and Lazuli Bunting; nearly significant for Hammond's Flycatcher and Mountain Chickadee; and not significant for Hermit Warbler, Red-winged Blackbird, Purple Finch, Pine Siskin, and all species pooled. All seven of the remaining species (Warbling Vireo, House Wren, Golden-crowned Kinglet, Yellow-rumped Warbler, MacGillivray's Warbler, Western Tanager, and Song Sparrow) showed non-substantial productivity trends. Overall, 15 of the 28 target species had positive productivity trends and 13 had negative productivity trends. The productivity trend for all species pooled indicated an average annual increase of 0.022 per year. These values were generally more positive than those recorded after 11 years (1993-2003) of data had been collected, reflecting the high productivity values recorded during 2004.

Thus, in summary, populations of adults of all species pooled at the four long-running stations combined at Yosemite National Park have shown a substantial and highly significant 12-year decline of -2.7% per year (-28% over the 12-year period), whereas productivity of all species pooled has shown a substantial but non-significant 12-year increase of +0.022 per year. Population trends for all species pooled over the 12-year period were negative at all four stations, being substantial at all but White Wolf, nearly significant at Hodgdon Meadow, and highly significant at Big Meadow, and with annual percent declines varying from -1.4% at Hodgdon Meadow to -5.9% at Big Meadow. Similarly, adult populations of 19 of 28 target species at the four long-running stations combined (and 24 of 37 target species at individual stations) have shown declining 12-year trends, while productivity trends at the four long-running stations combined showed a similar number of increases (15 species) and decreases (13 species).

Relationships of Population Trends, Productivity, and Elevation

To investigate the relationships among 12-year (1993-2004) population trends with elevation and reproductive indices, we modeled, for all species pooled at each of the four long-running stations: (**A**) the annual percentage change in adult population size (*APC*; Fig. 1), (**B**) the direction and strength of the correlation between adult population size and year (*r*; Fig. 1), and (**C**) the mean productivity index (Table 7) as functions of elevation; and (**D**) *APC* and (**E**) *r* as functions of mean productivity. The five graphs in Figure 9 indicate that population trends for all species pooled (Figs. 9**A** and 9**B**) generally became increasingly positive as elevation increased, from Big Meadow to White Wolf. Mean productivity generally showed the same relationship (Fig. 9**C**), which in turn resulted in population trends correlating positively with productivity (Figs. 9**D** and 9**E**). Although only one of these correlations (mean reproductive index by elevation) was so much as marginally significant (undoubtedly because of the small sample size of just four stations), these correlations suggest that the negative population trends at Yosemite, that became more negative at lower elevations, were likely driven by low productivity, which also became lower at lower elevations. Alternatively, for *APC* (but not *r*), it could be argued that only Big Meadow had a substantially more negative *APC* than the other three stations.

Productivity-Population Correlations

To see if productivity in a given year has had a direct effect on breeding population size the following year, we regressed the proportional change in the number of adults between year i+2 and year i+1 on the absolute change in productivity between year i+1 and year i for 28 target species and all species pooled from the four long-running stations in Yosemite National Park over the 12 years 1993-2004 (Fig. 10). The slopes and r-values in Figure 10, hereafter termed "productivity-population correlations", are used as indicators of the strength of this relationship. The productivity-population correlation was positive for 18 of 28 species and all species pooled. Ten species showed substantial positive correlations ($r \geq 0.3$): Hammond's Flycatcher, Warbling Vireo, House Wren, Hermit Thrush, American Robin, Yellow-rumped Warbler, Hermit Warbler, MacGillivray's Warbler, Western Tanager, and Lincoln's Sparrow; these correlations were significant or near-significant for Hammond's Flycatcher, House Wren, Hermit Thrush, American Robin, MacGillivray's Warbler, and Western Tanager. It is likely that productivity on the breeding grounds is a substantial contributing factor determining population fluctuation in these species. Of the remaining 10 species, only three (Western Wood-Pewee, Golden-crowned

Kinglet, and Purple Finch) showed substantial but non-significant negative correlations. Overall, these results support the concept that changes in productivity one year tend to correspond to changes in population size the next year for some species, but suggest that other factors besides productivity must be involved to bring about the observed annual changes in population size of other species.

Estimates of Adult Survivorship

Using 12 years of data (1993- 2004) from all five stations, we were able to obtain estimates of adult survival and recapture probabilities for 30 of the 38 target species breeding in Yosemite National Park (Tables 8-9). Because of the existence of floaters, failed breeders, and dispersing adults in bird populations, the transient model, which permits estimation of the proportion of residents in the population and allows survival estimates to be based on the resident population, will always produce less biased survivorship estimates than non-transient models. Thus, we only present results of the transient model. Table 8 indicates that the fully time-constant model ($\phi p \tau$) was selected over all time-dependent models for 27 of the 30 species by having an Akaike Information Criterion ($QAIC_C$) value that was at least 2.0 $QAIC_C$ units lower than that for any other model. For Warbling Vireo, a model detecting time-dependence in proportion of residents was the selected model; for Lincoln's Sparrow, models detecting time dependence in survival and recapture probability (each independently) were equivalent models; and for Dark-eyed Junco, the model detecting time-dependence in survival was the selected model. The high positive $\Delta QAIC_C$ values (> 7.0 for 28 of the 30 species) suggest that little interannual variation in survival exists for those species. Only for Lincoln's Sparrow (-2.4) and Dark-eyed Junco (-3.2) did the $\Delta QAIC_C$ value indicate substantial time-dependence in survival.

In Table 9, we present the maximum-likelihood time-constant estimates of annual adult survival, recapture probability, and proportion of residents, as well as the maximum-likelihood estimates for these parameters from the selected or equivalent time-dependent models identified in Table 8. Estimates of annual adult survival rate for the 30 species, using the time-constant model, ranged from a low of 0.212 for Purple Finch to a high of 0.839 for Cassin's Finch, with a mean of 0.505. Recapture probability varied from a low of 0.010 for Cassin's Finch to a high of 0.704 for Black Phoebe, with a mean of 0.305. Proportion of residents varied from a low of 0.096 for Hammond's Flycatcher to a high of 1.000 for eight species (Table 9), and averaged 0.608. The precision of these survival estimates continues to improve, even after 12 years of data have been collected. Of 19 species at Yosemite for which survival could be estimates using either 11 (1993-2003) or 12 (1993-2004) years of data, CV(ϕ) was lower (i.e., the estimate of ϕ was more precise) using 12 years of data than using 11 years of data for 17 of them (all but Yellow-rumped and Hermit warblers). The mean CV(ϕ) for these 19 species improved from 21.2% using 11 years of data (DeSante et al. 2004b) to 19.3% using 12 years of data.

The estimated survival estimate for adults at Yosemite (1993-2004) appears to be relatively good compared with values for the Northwestern MAPS region as a whole (1992-2001; see http://www.birdpop.org/nbii/surv/default.asp). Survival at Yosemite was higher than that of the Northwest Region for 20 of 29 species for which this comparison could be made (all but Black Phoebe, which lacked a value for the Northwest Region). The mean survival for these 29 species at Yosemite (0.507) was 6.7% higher than that of the Northwest Region (0.475). Eleven species

(Williamson's Sapsucker, Hairy Woodpecker, Western Wood-Pewee, Hammond's Flycatcher, Brown Creeper, Golden-crowned Kinglet, Western Tanager, Chipping Sparrow, Lincoln's Sparrow, Lazuli Bunting, and Cassin's Finch) showed substantially (>10%) higher values at Yosemite than in the Northwest Region, whereas only 5 species (Dusky Flycatcher, Mountain Chickadee, Yellow-rumped Warbler, Red-winged Blackbird, and Purple Finch) showed substantially lower survival at Yosemite.

For Warbling Vireo, proportion of residents was relatively high (> 0.5) in 1994, 1997, and 1998, and it was relatively low (< 0.2) in 1996 and 1999-2002. As of yet we have no explanation for inter-annual variation in proportion of residents. For Lincoln's Sparrow, adult survival was relatively high (> 0.6) during the winters of 1992-1993, 1998-1999, and 2002-2003, whereas it was relatively low (< 0.4) during the winters of 1994-1995, 1997-1998, and 2001-2002. Dark-eyed Junco showed a different pattern of inter-annual variation in survival, being relatively high during the winters of 1994-1995 and 2001-2002, and 2002-2003, and relatively low during the winters of 1993-1994, 1996-1997, 1997-1998, and 1999-2000. We suspect that these differences reflect differences in weather and food availability in Mexico and Central America vs. along the Pacific slope of California, where these two species winter, respectively. Recapture probability for Lincoln's Sparrow was relatively high (> 0.7) in 2002 and 2004, and relatively low (<0.4) in 1995, 1996, and 1998. We also have no explanation, as yet, for the causes of time dependence in recapture probability.

Productivity and Survival as a Function of Body Mass

It has previously been shown that both productivity and survival of birds vary with body mass: on average, the larger the bird the lower the productivity and the higher the survival. Thus, in order to assess whether or not productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. Figure 11 shows mean productivity indices and time-constant annual adult survival rate estimates recorded at Yosemite National Park as a function of mean body mass (log transformed) for 19 target species for which 12-year population trends could be calculated and relatively more precise survival estimates ($\geq$ 5 between-year returns, SE(ϕ) $\leq$ 0.2, and CV(ϕ) $\leq$ 50%) were obtained. The purpose of this analysis was to determine which species at Yosemite showed higher or lower productivity or survival than might be expected given their body mass. Two regression lines are presented on each graph, one (solid) for the 19 target species using data from Yosemite National Park, and one (dashed) using data from 210 (productivity) and 89 (survival) species for which these parameters could be estimated from MAPS data collected from stations distributed across the entire North American continent. For both productivity (Fig. 11**A**) and survival (Fig. 11**B**), the regression lines based on data from the 19 species at Yosemite were fairly similar to those based on data from North America as a whole, although productivity of smaller species generally appeared to be higher at Yosemite than in North America as a whole, resulting in a steeper (and significant) slope to the correlation with body mass.

Eleven of the 19 species shown in Figure 11 (species alpha codes in bold uppercase letters) showed substantial population declines (Figure 1). Six of these 11 species, Western Wood-Pewee (WEWP), Dusky Flycatcher (DUFL), Warbling Vireo (WAVI), Yellow Warbler (YWAR), Chipping Sparrow (CHSP), and Lazuli Bunting (LAZB), each showed substantially lower-than-expected productivity, at least as compared to the relationship between productivity and body mass at Yosemite. Five of the six species (all but Dusky Flycatcher) showed as-expected or better-than-expected adult survival. For these species it appears that low productivity at Yosemite is the major contributing factor to population declines at Yosemite. Dusky Flycatcher showed an adult survival rate that was slightly lower than expected, indicating that low adult survival may also be contributing to its decline. One species, Hermit Thrush (HETH), showed slightly lower-than-expected values for both productivity and survival, suggesting that both are contributing to its population decline. One species, Golden-crowned Kinglet (GCKI), showed lower-than-expected survival but better-than-expected productivity, suggesting that low survival is the major factor contributing to its population decline. The remaining three species, Hermit Warbler (HEWA), Lincoln's Sparrow (LISP), and Black-headed Grosbeak (BHGR) showed as-expected or better-than-expected values for both productivity and adult survival, suggesting that other factors (low first-winter survival or low recruitment) may be contributing to their population declines.

Three of the 19 species (shown in Figure 11 in non-bold uppercase letters) showed substantial population increases (Figure 1). Mountain Chickadee (MOCH), showed as-expected productivity (higher than expected when compared to that of North America as a whole) but lower-than-expected survival, and Yellow-rumped Warbler (YRWA) showed higher-than-expected productivity and slightly lower-than-expected survival, suggesting that good productivity at Yosemite is contributing to the population increases of these species (although productivity of cavity-nesting species such as Mountain Chickadee is generally higher than expected and survival lower than expected in relation to body mass). MacGillivray's Warbler (MGWA) showed slightly higher-than-expected survival and as-expected productivity, suggesting that good survival, probably away from Yosemite, is contributing to its population increase.

The remaining five species (shown in Figure 11 in non-bold lowercase letters) had non-substantial (and often widely fluctuating) population trends over the 12 years at Yosemite (see Fig. 1). Three of these species, Brown Creeper (brcr), Song Sparrow (sosp), and Dark-eyed Junco (deju) showed higher-than expected productivity and as-expected adult survival, suggesting that some other factor (low first-winter survival or low recruitment) may be counterbalancing the high productivity. The remaining two species, Red-breasted Sapsucker (rbsa) and American Robin (amro) showed, respectively, counter-balanced or close-to-expected productivity and survival values, which is an expected outcome in species with non-substantial population trends.

Causes of Population Declines and Increases Based on Demographic Data

Based on all of the above demographic data, we made assessments as to whether Yosemite population declines or increases were driven by productivity on the breeding grounds, adult survival presumably during migration and/or on the winter grounds, both, or neither (Table 10). Assessments for each species were based on a synthesis of productivity indices, productivity trends, survival estimates, $\Delta QAIC_C$ values, and productivity and survival values relative to body mass, and survival rates relative to those in the Northwestern MAPS region as a whole. As an example, for Dusky Flycatcher, a highly significantly decreasing species (Fig. 1) that also decreased at both stations at which it was a target species, Crane Flat (Fig. 3) and Hodgdon Meadow (Figs. 4 and 5), reproductive index was very low (0.16) based on the 12-year mean for all stations pooled (Table 7) and in comparison with body mass (Fig. 11); the productivity trend was substantially negative (Fig. 8); the productivity-population correlation was slightly positive (Fig. 10); survival (0.405; Table 9) was slightly lower than expected in comparison with body mass (Fig. 11) and 17% lower than that in the Northwestern MAPS region as a whole; and $\Delta QAIC_C$ was relatively high (+9.5; Table 8). In this case, all evidence suggests that low and decreasing productivity has been driving the significant population decrease for Dusky Flycatcher, although relatively low adult survival is also contributing to the decline. As another example, for Yellow-rumped Warbler, a substantially and near-significantly increasing species at Yosemite overall (Fig. 1) as well as at Crane Flat (Fig. 3), Hodgdon Meadow (Fig. 4), and Big Meadow (Fig. 6), reproductive index (0.46; Table 7) was higher than expected in comparison with body mass (Fig. 11); the productivity trend was highly fluctuating (Fig. 8); the productivity-population correlation was substantially positive (Fig. 10); survival (0.405; Table 9) was slightly lower than expected in comparison to body mass (Fig. 11) and was 25% lower than that recorded in the Northwestern MAPS region; and $\Delta QAIC_C$ was relatively high (+8.4; Table 8). Here, most or all of the evidence suggests that high productivity, rather than high survival, has been driving the population increase for Yellow-rumped Warbler at Yosemite.

Using this approach, we suggest that lower-than-expected productivity may be driving the population declines of seven of the eleven declining species, Western Wood-Pewee, Dusky Flycatcher, Warbling Vireo, Hermit Thrush, Yellow Warbler, Chipping Sparrow, and Lazuli Bunting (Table 10). As noted above, low survival may also be contributing to the population declines of Dusky Flycatcher and Hermit Thrush. Productivity for both Yellow Warbler and Lazuli Bunting is increasing so we might expect to see populations for these species rebounding in the future. The population decrease in Golden-crowned Kinglet appears to be due primarily to low survival, although we note that survival of this species was higher at Yosemite than in the Northwestern MAPS region as a whole. For the remaining three declining species, Hermit Warbler, Lincoln's Sparrow, and Black-headed Grosbeak, both productivity and survivorship were as-expected or higher than expected. We can only surmise that other factors not currently measured by MAPS (e.g., low intrinsic recruitment due to habitat degradation outside the Park, or low first-winter survival rates) are causing the population declines.

It also appears that higher-than-expected or as-expected productivity may be more of a factor in the population increases for Mountain Chickadee, Yellow-rumped Warbler, and MacGillivray's Warbler than adult survival (Table 10). Thus, overall, it appears that productivity at Yosemite is driving or contributing to the population dynamics of seven of the eleven declining species and all three increasing species, whereas survival appears only to be contributing to the declines of three species.

DISCUSSION AND CONCLUSIONS

Annual Changes in Adult Population Size and Productivity

Breeding populations in Yosemite National Park increased by a non-significant 10.7% in 2004 as compared with those of 2003; increases were recorded at all stations except Big Meadow. Productivity, however, showed a large, significant, station-wide increase of 113.5% from a reproductive index (young/adult) of 0.561 in 2003 to 1.198 in 2004. These are exactly opposite to the changes observed in 2003, when all stations except Big Meadow showed population declines and all stations showed significant productivity declines as compared with 2002.

It is relatively unusual to see both population size and productivity decrease in a given year, and even more unusual to then see both population size and productivity increase the following year, as has happened in Yosemite over the past two years. Rather, alternating cycles of population increases and decreases with out-of-phase decreases and increases in productivity is a much more frequently observed pattern at many MAPS locations across the continent. These alternating out-of-phase patterns are apparently caused by density-dependent effects on productivity and recruitment along with lower productivity of first-time breeders, and are typically reflected by positive productivity-population correlations. Thus, given the very low productivity in Yosemite in 2003, we would have expected to see a decrease in breeding populations in 2004, but, except for Big Meadow, this did not occur. Such alternating out-of-phase patterns in population size and productivity have been seen at Yosemite during certain years, for example between 1996 and 2001 (DeSante et al. 2004b), but are much more characteristic of other MAPS locations than Yosemite. In addition, although productivity-population correlations over the 12 years 1993-2004 were positive at Yosemite for 18 of 28 species and for all species pooled, generally supporting the idea that changes in productivity one year bring about corresponding changes in population size the next year, the productivity-population correlations at Yosemite were generally weaker than those at other national parks, including both Denali and Shenandoah.

Overall, an alternating out-of-phase density-dependent dynamic appears to be less strongly manifest in areas, such as Yosemite, that are characterized by high annual variation in weather and snowpack, than in areas where weather is more predictable year-round. Despite the 12 years of data now available over an elevation gradient at Yosemite National Park, there appears to be an additional dynamic involving density-independent, inter-annual recruitment probabilities that are related to climate, weather, and snowpack variables, and that likely affect one-year-old and adult birds differently, that we do not as yet understand. Clearly, the large magnitude of the weather perturbations (both regarding the extent of and timing of snowmelt as well as summer precipitation and temperatures) that affect montane environments, and the complex effects these perturbations likely have on avian population dynamics, means that long, consistent runs of monitoring data will be necessary to understand the causes of both short-term and long-term changes in Sierran bird populations. In the future, given adequate funding, we hope to undertake more detailed analyses and modeling of climate and recruitment rates of both one-year-old and adult birds, so as to more fully understand this dynamic at Yosemite.

Population and Productivity Trends of Yosemite's Birds

Populations of adult birds of all species pooled in Yosemite National Park have shown a substantial and highly significant decrease of -2.7% per year over the 12 years, 1993-2004. While this may not seem to be a large annual decline, it suggests that Yosemite's landbird populations have declined by 28% during the past 12 years, a truly substantial decrease. Population trends were negative at all four long-running stations, being nearly significant at Hodgdon Meadow and highly significant at Big Meadow, with annual percent declines ranging from -1.4% at Hodgdon Meadow to -5.9% at Big Meadow. Adult populations of 19 of 28 target species at the four long-running stations combined (and 24 of 37 target species at individual stations) showed declining 12-year trends. Substantial declines were shown by 13 species: Western Wood-Pewee, Dusky Flycatcher, Hammond's Flycatcher, Warbling Vireo, Golden-crowned Kinglet, Hermit Thrush, Yellow Warbler, Hermit Warbler, Chipping Sparrow, Lincoln's Sparrow, Black-headed Grosbeak, Lazuli Bunting, and Purple Finch. In contrast, populations of only three species showed substantial increasing trends: Mountain Chickadee, Yellow-rumped Warbler, and MacGillivray's Warbler.

Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata (see http://www.mbr-pwrc.usgs.gov/bbs/bbs.html) suggests that these dramatic declines for most landbird species in Yosemite are part of a Sierra-wide decline (DeSante et al. 2004b). Supporting this latter result, a comparison between the 41 species with population-size changes between 1991-1993 and 2001-2004, at both Yosemite and Sequoia/Kings Canyon, revealed that 28 showed changes in the same direction at both Yosemite and Sequoia/Kings Canyon and only 13 showed changes in the opposite direction (DeSante et al. 2005). Predictions from global climate models and recent weather data generally suggest that the Sierra Nevada region is becoming increasingly arid and that this drying tendency may be accelerating. Drier conditions tend to reduce food resources for landbirds; thus, these climate changes may underlie declining landbird populations observed in Yosemite and the Sierra. This possibility also underscores the importance of demographic monitoring data in aiding the understanding of the effects of global climate change on Sierra landbird populations.

In contrast to populations trends, trends of productivity showed a substantial but non-significant 12-year increase of +0.022 per year when all species were pooled. A similar number of species showed increases (15) and decreases (13). For most species and all species pooled, productivity was very low during the summer of 2003, but recovered markedly during the 2004 breeding season when the numbers of young birds captured of all species pooled increased by 136% over 2003 and productivity (the reproductive index, young/adult), increased by 113.5% over 2003. The cause of these huge differences in productivity at Yosemite is not entirely clear, although the roughly average snowpack present during the winter of 2003-04 reached its peak about March 1 whereas in 2002-03 it didn't reach its peak until about May 15. Apparently the very cold, wet May caused very poor reproductive success for most species' first brood attempts during 2003, whereas in 2004 breeding may have commenced earlier and was more productive.

In previous analyses we have also found a weak relationship between annual productivity for all species pooled at Yosemite and the El Niño/Southern Oscillation (ENSO), such that productivity tended to be higher during El Niño years, such as 2004 when a weak El Niño was present.

Although productivity tends to be higher at higher elevations and during warm wet El Niño years, the heavy late-melting snowpacks often associated with such years tended to reduce breeding population sizes, at least at higher elevations, by limiting recruitment of the previous year's young birds. Thus, despite increases in productivity, strong and frequent ENSO events and their associated El Niños tend to depress bird populations in Yosemite and throughout the Sierra. To the extent that the frequency and severity of such events is increased by anthropogenic climate change, the effect of such climate change on Sierra landbirds will be deleterious.

Overall, declining population trends coupled by stable or fluctuating productivity trends may suggest that other factors such as decreased overwinter survival or decreased recruitment into the breeding population may be causing the declines. However, productivity trend does not reflect whether or not productivity levels are high enough or low enough to sustain a population, and there is also substantial species-specific variation in productivity trends. In order to investigate the role of productivity in driving population trends at Yosemite, additional results need to be considered.

Demographics of Yosemite's Birds Along an Elevation Gradient

Twelve years (1993- 2004) of data from four MAPS stations (and seven years from a fifth) along an elevation gradient on the west slope of the Sierra Nevada in Yosemite National Park have shown that species richness (number of species), total adult population size, productivity, and adult population trend each varied with elevation in a unique way. Total species richness of breeding species was highest at the lowest elevation (Big Meadow – 63 species), lowest at the highest elevation (White Wolf Meadow – 40 species), and clearly decreased with increasing elevation. In marked contrast to total species richness, mean annual number of adults of all species pooled (essentially an index of total bird density) was highest at intermediate elevations (Crane Flat) and decreased progressively both at lower (Hodgdon and Big Meadows) and higher (Gin Flat East and White Wolf) elevations.

In further contrast, mean annual productivity for all species pooled was highest at still higher elevations (Gin Flat East) and, again, decreased progressively both at lower (Crane Flat, Hodgdon Meadow, and Big Meadow) and higher (White Wolf) elevations. Excluding Gin Flat East, which has only been operated for seven years, productivity showed a positive correlation with elevation. Station-specific, 12-year population trends for all species pooled also correlated positively with elevation; e.g., the trend was non-significantly negative at White Wolf but highly significantly negative at Big Meadow. Although none of these correlations was significant (probably due to the small number of stations), they suggest that the increasingly negative population trends at lower elevation stations may have been driven by the increasingly lower productivity at those same stations, especially during drought years with meager snowpacks. These elevation-specific results may provide further evidence that long-term drying tendencies in the Sierra Nevada may be influencing landbird population declines.

Survival Rates of Yosemite's Birds

We were able to obtain estimates of annual adult survival for 30 target species at Yosemite using 12 years of data from all five stations combined. As mentioned in previous reports, increased years of data have resulted in increased numbers of species for which survival estimates could be obtained. In addition, the mean precision of these survival rate estimates has increased substantially with each additional year of data. For example, the mean CV(ϕ) for 19 species using 1993-2004 data (19.3%) continues to show improvement over the mean CV for the same 19 species using 1993-2003 data (21.2%; DeSante et al. 2004b). These results suggest that maximum precision may not be obtained until more than 12 years of data are available; Rosenberg (1996) and Rosenberg et al. (1999) suggested that precision should level off after 12 years of data have been collected. $\Delta QAIC_C$ values were relatively high (> 7.0) in all but two (Lincoln's Sparrow and Dark-eyed Junco) of these 30 species, suggesting that there is relatively little interannual variation in survival for most Yosemite species.

The estimated annual adult survival rates at Yosemite (1993-2004) appear to be relatively good compared with values for the Northwestern MAPS region as a whole, being higher than that of the Northwest Region for 20 of 29 species for which this comparison could be made, and showing a mean annual adult survival rate at Yosemite (0.507) that was 6.7% higher than that of the Northwest Region (0.475). In addition, DeSante et al. (2005) found that 11 of 17 species showed higher survival at Hodgdon Meadow than at equivalent elevations in Sequoia/Kings Canyon National Park. This suggests that survival of birds breeding at Yosemite is good, overall. It is possible that the generally lower survival rates observed at Sequoia/Kings Canyon may relate to local stressors acting on the breeding grounds which can affect annual survival of adults. It is not inconceivable that higher levels of air pollution and airborne contaminants at Sequoia/Kings Canyon than at Yosemite could be driving these differences in annual survival observed between these two locations.

Causes of Population Changes in Yosemite's Birds

Based on all demographic data, we made assessments as to whether population declines or increases in Yosemite were driven by productivity on the breeding grounds, survival presumably during migration and/or on the winter grounds, both, or neither. Lower-than-expected productivity appears to be driving or contributing to the population declines of seven of 11 declining species, Western Wood-Pewee, Dusky Flycatcher, Warbling Vireo, Hermit Thrush, Yellow Warbler, Chipping Sparrow, and Lazuli Bunting, while low survivorship may also be contributing to the declines of Dusky Flycatcher and Hermit Thrush. Only the decline of Golden-crowned Kinglet appears to be driven solely by low survival, although survival of this species was over 100% higher at Yosemite than in the Northwestern MAPS region as a whole. Similarly, it appears that higher than expected or increasing productivity may be driving the population changes of all three increasing species, Mountain Chickadee, Yellow-rumped Warbler, and MacGillivray's Warbler, with higher survival also contributing to the increase in MacGillivray's Warbler. Thus, overall, it appears that productivity at Yosemite is driving or influencing the population dynamics of ten of the 14 species showing substantial trends, whereas survival away from Yosemite is only driving or influencing trends in three species. This indicates that the population dynamics of most of Yosemite's breeding species are being affected by events in Yosemite National Park, and could be within the Park's ability to influence through management action.

Future Analyses

We cannot estimate first year survival with current MAPS analyses. This is because young birds typically disperse substantial distances from their natal site to their site of first breeding, resulting in very few or no recaptures of birds banded as juveniles. In future analyses we hope to be able to index first year survival by using data on species for which we can identify both one-year-old (second-year; SY) and older (after-second-year; ASY) birds in spring and using CJS mark-recapture models to estimate annual recruitment of both SY and ASY birds. Then, by comparing spatial and temporal patterns of productivity and recruitment of SY and ASY birds, we will be able to make inferences regarding first year survival rates as well as amounts of immigration and emigration in the populations. Once these analyses have been performed, we will be able to examine patterns in adult and first year survival rates according to geographic location, climate, and habitat considerations, and to identify species (e.g., declining species at Yosemite that do not show deficient productivity or adult survival, such as Hermit Warbler, Dark-eyed Junco, and Black-headed Grosbeak) for which declines may be driven by low first year survival and/or a declining recruitment rate.

In three more years, when we will have 15 consecutive years of data from each of the four long-running stations, we hope to perform many of these park-wide analyses at the spatial scale of the four individual stations. This may yield especially important results at Yosemite, where the stations span such a significant elevation range and the population dynamics appear to be influenced by elevation. Once these analyses have been completed we will be able not only to identify the effects of elevation on various demographic processes, but also identify species that are declining based on poor productivity at each station (or within each of the parks elevation regimes), and make recommendations for management of these species accordingly.

We have recently initiated additional broad-scale analyses to help us further understand the population dynamics of landbirds and potential management actions to assist bird populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to determine the proximate demographic causes of population trends for various species on both continental and regional spatial scales (DeSante et al. 2001). Analyses of spatial variation in productivity and survival as a function of spatial variation in population trends appear to be very effective in understanding causes of population declines. We hope to undertake such analyses (e.g., between Sierra stations within and outside of Yosemite) sometime in the future, when we will have accumulated about 15 years of data.

Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area around each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well (Nott 2000). For Wilson's Warblers in Pacific Northwest national forests, for example, we found that the amount of deciduous forest cover in otherwise coniferous forest matrices within two km of the stations correlated positively and highly significantly with breeding population size, but non-significantly with productivity, indicating that increasing the deciduous component of these forests can increase adult population size without compromising productivity. These types of analyses provide extremely powerful tools to identify and formulate management actions aimed at reversing declining populations and maintaining stable or increasing populations of landbirds, because they can address the particular vital rate responsible for the decline. We plan to conduct similar analyses for the target species in the Sierra, by modeling productivity as a function of various landscape characteristics that vary along a gradient from the pristine landscapes found in Yosemite National Park to the much more heavily managed landscapes on Sierran national forests where we also have MAPS stations. Again, given adequate funding, we plan to conduct such analyses after we have accumulated about 15 years of data.

One important objective of the MAPS Program in relatively pristine protected areas such as large national parks like Yosemite is to provide control data on the vital rates of landbird species in order to aid the identification of generalized management guidelines and the formulation of specific management actions that can be implemented to reverse the population declines of focal or priority landbird species and to maintain the populations of stable or increasing species. The identification and formulation of these management guidelines and actions are to be achieved by modeling the vital rates (productivity, adult survival, first-year survival, and/or recruitment rates) of the various landbird species as a function of landscape-level and elevation-specific habitat characteristics along with spatially explicit weather variables. Management strategies will subsequently involve efforts to modify habitat characteristics from those associated with low productivity or recruitment to those associated with high productivity or recruitment (for species for which low productivity or recruitment is driving the population decline). We are currently in our third year of implementing such guidelines and actions on eight military installations in Eastern North America, and beginning the first such year on six national forests in the Pacific Northwest.

Because of the pronounced elevation factor at Yosemite, and the complex effects of weather on population size and productivity, we will need to incorporate elevation-specific habitat analyses and account for weather on an annual basis. Elevation effects on adult population size appear to reflect the effects of dry years (greater population sizes at higher elevations due to lack of snow pack and warmer temperatures) vs. wet years (greater population sizes at lower elevations due to higher levels of food resources and cooler temperatures). Thus, landscape-level analyses at Yosemite will necessarily involve interactions between elevation and weather as well as habitat characteristics. It is the complexity of these interactions that create the need for long-term data.

Conclusions

Analyses of 12 years of MAPS data from four stations along an elevation gradient in Yosemite National Park, plus seven years of data from a fifth station, have shown that bird populations in Yosemite have decreased significantly over the 12 years with substantially more species decreasing than increasing. These data have also shown that species richness, total bird density, productivity, and population trends all vary with elevation in generally different ways. We have also demonstrated how MAPS data can be used to measure and assess the effects of productivity and survivorship as driving forces for the varying avian population trends documented in Yosemite National Park, both overall and at the individual species level. In future analyses, we hope to include estimates of first-year and adult recruitment and indices of first-year survival in order to more fully understand what parameters are most affecting population changes in each target species.

This report demonstrates that the indices and estimates of primary demographic parameters produced by the Yosemite MAPS Program are providing critical information that will be extremely useful for the management and conservation of landbirds in the Sierra Nevada and, in combination with similar data from other areas, across the whole of North America. The results highlighted above have also revealed that the population dynamics of the breeding birds of Yosemite National Park are complex, as are the likely causes of the dynamics and, for those trends deemed problematic, their solutions. This complexity, in turn, underscores the importance of standardized, long-term data. Once 15 years of data have accumulated and the precision of our estimates improves further, and both short- and long-term trends are more clearly established, we will be able to incorporate weather and climate data as well as landscape-level habitat data as additional co-variates in logistic regression analyses of productivity and in survivorship models. We believe that, with these additional years of data, we will be able to further our understanding of the population dynamics of Yosemite's birds and shed more light on the complex paths leading from stressors to population responses.

Results from the first 12 years of the MAPS Program in Yosemite National Park (15 years at the Hodgdon Meadow station), as documented in this report, indicate that meaningful station-specific indices of adult population size and post-fledging productivity, precise park-wide estimates of annual survival rates of adults, and important information on annual changes, longer-term trends, and elevation differences in these indices and estimates are being obtained for up to 33 target species. We conclude that the MAPS protocol is very well-suited to provide a critical component of the Park Service's Long-Term Ecological Monitoring program in Yosemite National Park. Based on the above information, we recommended that the operation of the five MAPS stations currently active in Yosemite National Park be sustained indefinitely into the future, and a comprehensive analysis of all Sierran MAPS data (including Yosemite's) be conducted after 15 years of data have been accumulated, that is, depending on the availability of additional funding for these analyses, after the 2007 field season.

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Table 1. Summary of the 2004 MAPS program in Yosemite National Park.

Station					Avg	2004 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Elev. (m)	Total number of net-hours[1]	No. of periods	Inclusive dates
White Wolf	WHWO	11904	Wet montane meadow, red fir/ lodgepole pine forest	37˚52'10"N,-119˚39'08"W	2402	364.0 (292.7)	7	6/08 - 8/03
Gin Flat East Meadow	GFEM	11980	Wet montane meadow, mixed fir forest	37˚45'59"N,-119˚45'37"W	2073	415.0 (370.5)	7	6/07 - 8/02
Crane Flat	CRFL	11907	Wet montane meadow, willow/ aspen thickets, mixed coniferous forest	37˚45'20"N,-119˚48'13"W	1875	438.8 (414.3)	8	5/23 - 8/01
Hodgdon Meadow	HODG	11107	Wet montane meadow, willow/ dogwood thickets, mixed oak and coniferous forest	37˚47'41"N,-119˚51'50"W	1408	594.0 (514.8)	8	5/21 - 7/31
Big Meadow	BIME	11905	Riparian willows, mixed coniferous forest, open dry meadow	37˚42'16"N,-119˚45'07"W	1311	395.3 (366.2)	8	5/24 - 8/04
ALL STATIONS COMBINED						2207.2 (1958.5)	8	5/21 - 8/04

[1] Total net-hours in 2004. Net-hours in 2004 that could be compared in a constant-effort manner to 2003 are shown in parentheses.

Table 2. Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Mountain Quail														1			1	
Black-chinned Hummingbird								1			1			1			3	
Anna's Hummingbird					5			2			35			17			59	
Calliope Hummingbird					1			1			5			3			10	
Rufous Hummingbird		2			3						5			3			13	
Allen's Hummingbird		1			1			3			3						8	
Unidentified Selasphorus H.		3			13			8			6			2			32	
Unidentified Hummingbird					2			5			6			4			17	
Williamson's Sapsucker	2		2													2		2
Red-breasted Sapsucker	2			6		2	3		2	21		5	4		1	36		10
Downy Woodpecker												1						1
Hairy Woodpecker	1			3												4		
White-headed Woodpecker							5						1		1	6		1
Northern Flicker	1			1			1			1			1		1	5		1
Western Wood-Pewee							1			6		3	1		2	8		5
"Traill's" Flycatcher													2			2		
Hammond's Flycatcher	2			4			3			1						10		
Dusky Flycatcher	2		1	7			7			2		1	1			19		2
"Western" Flycatcher	1			1	1		12			22	1					36	2	
Unident. Empidonax Flycat..		1			5			6									12	
Black Phoebe				2			1						8		2	11		2
Cassin's Vireo				1			4			5						10		
Hutton's Vireo							1									1		
Warbling Vireo				4			16		8	27	1	7	3		4	50	1	19
Steller's Jay							1			2						3		
Western Scrub-Jay													1			1		

Table 2. (cont.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Mountain Chickadee	2			20		6	8			3						33		6
Chestnut-backed Chickadee										1						1		
Bushtit										8			18	2	4	26	2	4
Red-breasted Nuthatch	2			6		1	19		2	5						32		3
White-breasted Nuthatch															2			2
Brown Creeper	7			8		3	6			7			4			32		3
Bewick's Wren													3		1	3		1
House Wren	6		1	5			8		1	9		3	3	3	2	31	3	7
Winter Wren										2						2		
Golden-crowned Kinglet	2			7			16	1		7	1					32	2	
Hermit Thrush	1						2			2			1			6		
American Robin	1		2	4			1			7	1	2	2	1		15	2	4
Wrentit													5		5	5		5
European Starling														2			2	
Orange-crowned Warbler	12		3	72	7		115	1	5	152	3	14	82	2	9	433	13	31
Nashville Warbler	22			42	2		35	1	1	12		1	20		5	131	3	7
Yellow Warbler										5		2	8		9	13		11
Yellow-rumped Warbler	14		1	147	1	4	58		5	9			1			229	1	10
Black-throated Gray Warbler				1			5			2			2			10		
Townsend's Warbler				1			4									5		
Hermit Warbler	2			33	1		56		2	14						105	1	2
MacGillivray's Warbler				13		1	28	1	16	48	3	47	9		1	98	4	65
Wilson's Warbler	1			6			6			3			1			17		
Unidentified Warbler											1						1	
Western Tanager				7	1		4			6			3			20	1	
Green-tailed Towhee						2	3		1							3		3

Table 2. (cont.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Spotted Towhee										2		1	8	2	3	10	2	4
Chipping Sparrow							3		1							3		1
Fox Sparrow	1			2												3		
Song Sparrow										44	6	28	3		3	47	6	31
Lincoln's Sparrow	13	1	11	44	1	29	45	3	39	7		13		2		109	7	92
Dark-eyed Junco	55	3	26	42		16	78	2	40	31	2	10	2			208	7	92
Rose-breasted Grosbeak										1						1		
Black-headed Grosbeak										12		5	27		1	39		6
Lazuli Bunting							3						5			8		
Red-winged Blackbird										1						1		
Brewer's Blackbird							1						1			2		
Brown-headed Cowbird													1			1		
Bullock's Oriole													2			2		
Pine Grosbeak	1															1		
Purple Finch							1					1	33	1		34	1	1
Cassin's Finch	1			2			1						2			6		
Unidentified Carpodacus Finch														5			5	
Pine Siskin				16		1	1			2						19		1
Lesser Goldfinch				3	1								4			7	1	
ALL SPECIES POOLED	154	11	47	510	45	65	562	35	123	489	80	144	272	51	56	1987	222	435
Total Number of Captures		212			620			720			713			379			2644	
Number of Species	24	6	8	30	15	10	37	13	13	36	16	17	35	16	18	57	25	33
Total Number of Species		28			38			44			46			46			66	

Table 3. Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Williamson's Sapsucker	4.9	1.6	0.33													0.8	0.3	0.33
Red-breasted Sapsucker	3.3	0.0	0.00	4.3	2.9	0.67	4.1	1.4	0.33	16.2	5.1	0.31	1.5	4.6	3.00	6.8	3.0	0.44
Downy Woodpecker										1.0	0.0	0.00				0.3	0.0	0.00
Hairy Woodpecker	0.0	1.6	und.[1]	1.4	2.9	2.00										0.3	0.8	3.00
White-headed Woodpecker							4.1	2.7	0.67				1.5	1.5	1.00	1.1	0.8	0.75
Northern Flicker	1.6	0.0	0.00	1.4	0.0	0.00	1.4	0.0	0.00	1.0	0.0	0.00	1.5	1.5	1.00	1.4	0.3	0.20
Western Wood-Pewee							0.0	1.4	und.[1]	5.1	1.0	0.20	4.6	0.0	0.00	2.2	0.5	0.25
"Traill's" Flycatcher													3.0	0.0	0.00	0.5	0.0	0.00
Hammond's Flycatcher	0.0	3.3	und.	1.4	4.3	3.00	1.4	2.7	2.00	0.0	1.0	und.[1]				0.5	2.2	4.00
Dusky Flycatcher	3.3	0.0	0.00	8.7	1.4	0.17	9.6	0.0	0.00	3.0	0.0	0.00	1.5	0.0	0.00	5.2	0.3	0.05
"Western" Flycatcher	1.6	0.0	0.00	0.0	1.4	und.[1]	9.6	6.8	0.71	9.1	13.1	1.44				4.6	5.2	1.12
Black Phoebe				0.0	2.9	und.	1.4	0.0	0.00				4.6	9.1	2.00	1.1	2.2	2.00
Cassin's Vireo				1.4	0.0	0.00	2.7	2.7	1.00	3.0	2.0	0.67				1.6	1.1	0.67
Hutton's Vireo							0.0	1.4	und.							0.0	0.3	und.[1]
Warbling Vireo				5.8	0.0	0.00	19.1	5.5	0.29	19.2	11.1	0.58	4.6	0.0	0.00	10.9	4.1	0.38
Steller's Jay							1.4	0.0	0.00	2.0	0.0	0.00				0.8	0.0	0.00
Western Scrub-Jay													1.5	0.0	0.00	0.3	0.0	0.00
Mountain Chickadee	1.6	1.6	1.00	18.8	14.5	0.77	1.4	9.6	7.00	2.0	1.0	0.50				4.6	5.2	1.12
Chestnut-backed Chickadee										0.0	1.0	und.				0.0	0.3	und.
Bushtit										0.0	8.1	und.	18.2	7.6	0.42	3.3	3.5	1.08
Red-breasted Nuthatch	0.0	3.3	und.	4.3	5.8	1.33	4.1	21.9	5.33	1.0	4.0	4.00				1.9	7.1	3.71

Table 3. (cont.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
White-breasted Nuthatch													3.0	0.0	0.00	0.5	0.0	0.00
Brown Creeper	1.6	9.9	6.00	5.8	7.2	1.25	2.7	5.5	2.00	1.0	6.1	6.00	1.5	4.6	3.00	2.4	6.5	2.67
Bewick's Wren													1.5	3.0	2.00	0.3	0.5	2.00
House Wren													3.0	1.5	0.50	0.5	0.3	0.50
Winter Wren										0.0	2.0	und.				0.0	0.5	und.
Golden-crowned Kinglet	3.3	0.0	0.00	4.3	5.8	1.33	6.8	15.0	2.20	0.0	8.1	und.				2.7	6.3	2.30
Hermit Thrush	1.6	0.0	0.00				2.7	0.0	0.00	2.0	0.0	0.00	1.5	0.0	0.00	1.6	0.0	0.00
American Robin	4.9	0.0	0.00	4.3	1.4	0.33	0.0	1.4	und.	6.1	2.0	0.33	3.0	0.0	0.00	3.8	1.1	0.29
Wrentit													4.6	1.5	0.33	0.8	0.3	0.33
European Starling													0.0	0.0	0.00	0.0	0.0	und.
Nashville Warbler										2.0	10.1	5.00	15.2	15.2	1.00	3.3	5.4	1.67
Yellow Warbler										3.0	2.0	0.67	10.6	4.6	0.43	2.7	1.4	0.50
Yellow-rumped Warbler	16.5	6.6	0.40	34.7	179.3	5.17	28.7	50.6	1.76	5.1	4.0	0.80	1.5	0.0	0.00	16.6	45.9	2.77
Black-throated Gray Warbler				0.0	1.4	und.	0.0	6.8	und.	0.0	2.0	und.	1.5	1.5	1.00	0.3	2.4	9.00
Hermit Warbler	1.6	1.6	1.00	8.7	39.0	4.50	13.7	62.9	4.60	8.1	6.1	0.75				6.8	21.7	3.20
MacGillivray's Warbler				13.0	5.8	0.44	23.2	17.8	0.76	39.4	24.2	0.62	4.6	7.6	1.67	18.5	12.5	0.68
Wilson's Warbler	0.0	1.6	und.	0.0	8.7	und.	0.0	8.2	und.	0.0	3.0	und.	0.0	1.5	und.[1]	0.0	4.6	und.
Western Tanager				7.2	2.9	0.40	0.0	5.5	und.	3.0	2.0	0.67	4.6	0.0	0.00	3.0	2.2	0.73
Green-tailed Towhee				1.4	0.0	0.00	4.1	0.0	0.00							0.8	0.0	0.00
Spotted Towhee										3.0	0.0	0.00	6.1	9.1	1.50	1.9	1.6	0.86
Chipping Sparrow							4.1	1.4	0.33							0.8	0.3	0.33

Table 3. (cont.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2004.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Fox Sparrow	0.0	1.6	und.	0.0	2.9	und.										0.0	0.8	und.
Song Sparrow										22.2	33.3	1.50	4.6	3.0	0.67	6.8	9.5	1.40
Lincoln's Sparrow	13.2	9.9	0.75	50.6	24.6	0.49	30.1	41.0	1.36	10.1	4.0	0.40				20.4	15.5	0.76
Dark-eyed Junco	69.2	31.3	0.45	31.8	37.6	1.18	75.2	53.3	0.71	18.2	17.2	0.94	3.0	0.0	0.00	37.8	27.5	0.73
Black-headed Grosbeak										10.1	4.0	0.40	4.6	36.4	8.00	3.5	7.6	2.15
Lazuli Bunting							1.4	2.7	2.00				3.0	4.6	1.50	0.8	1.4	1.67
Red-winged Blackbird										0.0	1.0	und.				0.0	0.3	und.
Brewer's Blackbird							0.0	1.4	und.				1.5	0.0	0.00	0.3	0.3	1.00
Brown-headed Cowbird													1.5	0.0	0.00	0.3	0.0	0.00
Bullock's Oriole													3.0	0.0	0.00	0.5	0.0	0.00
Pine Grosbeak	0.0	1.6	und.													0.0	0.3	und.
Purple Finch							1.4	0.0	0.00	1.0	0.0	0.00	4.6	47.0	10.33	1.4	8.4	6.20
Cassin's Finch	1.6	0.0	0.00	2.9	0.0	0.00	1.4	0.0	0.00				0.0	3.0	und.	1.1	0.5	0.50
Pine Siskin				14.5	8.7	0.60	1.4	0.0	0.00	0.0	2.0	und.				3.0	2.2	0.73
Lesser Goldfinch				2.9	1.4	0.50							3.0	3.0	1.00	1.1	0.8	0.75
ALL SPECIES POOLED	130.2	75.8	0.58	229.9	362.9	1.58	257.0	329.5	1.28	197.0	180.8	0.92	133.6	171.5	1.28	192.5	225.6	1.17
Number of Species	15	13		22	22		26	24		26	28		33	21		49	47	
Total Number of Species		21			27			33			35			35			56	

[1] Reproductive index (young/adult) is undefined because no adults of this species were captured at this station in this year.

Table 4. Percentage changes between 2003 and 2004 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

						All five stations combined				
							Number of adults			
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Percent change	SE[2]
Acorn Woodpecker					-100.0	1	1	0	-100.0	
Williamson's Sapsucker	50.0					1	2	3	50.0	
Red-breasted Sapsucker	100.0	-57.1	200.0	300.0	-50.0	5	15	25	66.7	97.1
Downy Woodpecker				++++[3]	-100.0	2	3	1	-66.7	66.7
Hairy Woodpecker		0.0	-100.0	-100.0		3	3	1	-66.7	33.3
White-headed Woodpecker		-100.0	200.0	-100.0	-66.7	4	8	4	-50.0	42.1
Northern Flicker	++++[3]	0.0	++++[3]	0.0	-66.7	5	5	5	0.0	54.8
Olive-sided Flycatcher				-100.0		1	2	0	-100.0	
Western Wood-Pewee	-100.0	-100.0		200.0	-33.3	4	9	5	-44.4	43.2
"Traill's" Flycatcher					100.0	1	1	2	100.0	
Hammond's Flycatcher		-75.0	-75.0			2	8	2	-75.0	88.9
Dusky Flycatcher	++++	500.0	-50.0	-66.7		4	21	17	-19.0	41.8
"Western" Flycatcher	++++	-100.0	250.0	100.0		4	7	16	128.6	60.4
Black Phoebe			++++	-100.0	-66.7	3	7	3	-57.1	21.5
Cassin's Vireo		0.0	100.0	-25.0		3	6	6	0.0	28.9
Hutton's Vireo						0	0	0		
Warbling Vireo	-100.0	300.0	7.7	12.5	50.0	5	34	39	14.7	12.7
Steller's Jay			++++	100.0	-100.0	3	2	3	50.0	114.6
Western Scrub-Jay					++++[3]	1	0	1	++++[3]	
Mountain Chickadee	-50.0	44.4	-90.9	100.0		4	23	17	-26.1	48.4
Chestnut-backed Chickadee				-100.0		1	1	0	-100.0	
Bushtit					1000.0	1	1	11	1000.0	
Red-breasted Nuthatch		50.0	++++	0.0		3	3	7	133.3	150.3
White-breasted Nuthatch		-100.0			-50.0	2	5	2	-60.0	16.0

Table 4. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	All five stations combined: Number of adults 2003	2004	Percent change	SE[2]	
Brown Creeper	-100.0	33.3	-50.0	0.0	0.0	5	10	8	-20.0	24.3	
Bewick's Wren					++++	1	0	1	++++		
House Wren					++++	1	0	2	++++		
Winter Wren						0	0	0			
Golden-crowned Kinglet	-75.0	0.0	25.0	-100.0		4	12	9	-25.0	29.1	
Townsend's Solitaire						0	0	0			
Hermit Thrush	-50.0	-100.0	-33.3	-50.0	++++	5	8	5	-37.5	17.3	*
American Robin	-85.7	-40.0	-100.0	150.0	100.0	5	18	11	-38.9	34.2	
Wrentit					0.0	1	3	3	0.0		
Nashville Warbler				0.0	233.3	2	5	12	140.0	112.0	
Yellow Warbler				50.0	16.7	2	8	10	25.0	12.5	
Yellow-rumped Warbler	60.0	60.0	31.3	66.7	-66.7	5	42	59	40.5	12.7	**
Black-throated Gray Warb.					++++	1	0	1	++++		
Hermit Warbler	0.0	500.0	42.9	-50.0		4	25	25	0.0	45.7	
MacGillivray's Warbler		125.0	60.0	17.9	0.0	4	45	61	35.6	17.1	
Wilson's Warbler						0	0	0			
Western Tanager		-37.5	-100.0	-66.7	50.0	4	17	10	-41.2	16.8	*
Green-tailed Towhee		0.0	++++		-100.0	3	2	4	100.0	229.1	
Spotted Towhee				50.0	-60.0	2	12	7	-41.7	30.6	
Chipping Sparrow	-100.0		-50.0	-100.0		3	10	3	-70.0	18.7	*
Fox Sparrow			-100.0			1	1	0	-100.0		
Song Sparrow				10.0	200.0	2	21	25	19.0	17.2	
Lincoln's Sparrow	++++	126.7	57.1	0.0		4	39	72	84.6	37.7	
Dark-eyed Junco	129.4	16.7	83.3	54.5	++++	5	76	134	76.3	21.4	**

Table 4. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	All five stations combined: Number of adults 2003	2004	Percent change	SE[2]	
Black-headed Grosbeak				-10.0	-50.0	2	16	12	-25.0	18.8	
Lazuli Bunting		-100.0	-85.7		-92.3	3	21	2	-90.5	2.5	***
Red-winged Blackbird				-100.0		1	1	0	-100.0		
Brewer's Blackbird				-100.0	-66.7	2	4	1	-75.0	12.5	
Brown-headed Cowbird				-100.0	++++	2	1	1	0.0	200.0	
Bullock's Oriole					++++	1	0	2	++++		
Pine Grosbeak	-100.0					1	1	0	-100.0		
Purple Finch			++++	-88.9	-75.0	3	17	4	-76.5	10.8	**
Cassin's Finch	-66.7	100.0	0.0	-100.0		4	6	4	-33.3	35.1	
House Finch						0	0	0			
Pine Siskin		100.0	++++	-100.0		3	7	11	57.1	68.8	
Lesser Goldfinch		0.0			-80.0	2	12	4	-66.7	22.2	
Evening Grosbeak					-100.0	1	1	0	-100.0		
ALL SPECIES POOLED	30.8	33.1	20.6	0.6	-21.9	5	608	673	10.7	9.3	
No. species that increased[4]	8(4)	12(0)	18(7)	14(1)	16(8)				22(5)		
No. species that decreased[5]	10(5)	10(6)	11(4)	19(12)	18(5)				29(7)		
No. species remained same	1	6	1	5	3				5		
Total Number of Species	19	28	30	38	37				56		
Proportion of increasing (decreasing) species	0.421	0.429	0.600	0.368	(0.486)				0.393		
Sig. of increase (decrease)[6]	0.820	0.828	0.181	0.964	(0.629)				0.959		

Table 4. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

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[1] Number of stations lying within the breeding range of the species at which at least one individual adult bird of the species was captured in either year.
[2] Standard error of the percent change in the number of individual adults captured.
[3] Increase indeterminate (infinite) because no adult was captured during 2003.
[4] No. of species for which adults were captured in 2004 but not in 2003 are in parentheses.
[5] No. of species for which adults were captured in 2003 but not in 2004 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 5. Percentage changes between 2003 and 2004 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

						All five stations combined				
							Number of young			
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Percent change	SE[2]
Acorn Woodpecker						0	0	0		
Williamson's Sapsucker	++++[3]					1	0	1	++++[3]	
Red-breasted Sapsucker		++++[3]	0.0	400.0	++++[3]	4	2	11	450.0	334.2
Downy Woodpecker				-100.0		1	1	0	-100.0	
Hairy Woodpecker	++++	++++			-100.0	3	1	3	200.0	458.3
White-headed Woodpecker			++++[3]		++++	2	0	3	++++	
Northern Flicker					++++	1	0	1	++++	
Olive-sided Flycatcher						0	0	0		
Western Wood-Pewee			++++	0.0		2	1	2	100.0	200.0
"Traill's" Flycatcher						0	0	0		
Hammond's Flycatcher	++++	-75.0	100.0	0.0		4	14	8	-42.9	37.9
Dusky Flycatcher		++++		-100.0		2	2	1	-50.0	100.0
"Western" Flycatcher		++++	++++	550.0		3	2	19	850.0	482.2
Black Phoebe		++++			100.0	2	3	8	166.7	133.3
Cassin's Vireo			++++	-33.3		2	3	4	33.3	133.3
Hutton's Vireo			++++			1	0	1	++++	
Warbling Vireo			33.3	120.0	-100.0	3	9	15	66.7	44.9
Steller's Jay				-100.0		1	1	0	-100.0	
Western Scrub-Jay						0	0	0		
Mountain Chickadee	++++	66.7	++++	++++[3]		4	6	19	216.7	221.1
Chestnut-backed Chickadee				0.0		1	1	1	0.0	
Bushtit				++++	100.0	2	2	12	500.0	800.0
Red-breasted Nuthatch	++++	-20.0	433.3	++++		4	8	26	225.0	208.7
White-breasted Nuthatch						0	0	0		

Table 5. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

						All five stations combined					
						Number of young					
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Percent change	SE[2]	
Brown Creeper	++++	25.0	-42.9	25.0	100.0	5	16	21	31.3	50.6	
Bewick's Wren					++++	1	0	1	++++		
House Wren					0.0	1	1	1	0.0		
Winter Wren				++++		1	0	2	++++		
Golden-crowned Kinglet		-88.6	450.0	++++		3	37	23	-37.8	72.1	
Townsend's Solitaire		-100.0				1	1	0	-100.0		
Hermit Thrush				-100.0		1	1	0	-100.0		
American Robin		0.0	++++	100.0		3	2	4	100.0	86.6	
Wrentit					-50.0	1	2	1	-50.0		
Nashville Warbler				700.0	400.0	2	3	18	500.0	133.3	
Yellow Warbler			-100.0	0.0	-33.3	3	6	4	-33.3	19.2	
Yellow-rumped Warbler	100.0	421.7	270.0	33.3		4	38	165	334.2	71.3	**
Black-throated Gray Warb.		++++	++++	++++	++++	4	0	9	++++		
Hermit Warbler	++++	++++	4500.0	500.0		4	2	80	3900.0	2531.1	
MacGillivray's Warbler		100.0	30.0	15.0	400.0	4	33	45	36.4	20.3	
Wilson's Warbler	++++	++++	++++	200.0	0.0	5	2	17	750.0	706.0	
Western Tanager		0.0	300.0	100.0		3	4	8	100.0	86.6	
Green-tailed Towhee						0	0	0			
Spotted Towhee				-100.0	500.0	2	2	6	200.0	300.0	
Chipping Sparrow			0.0			1	1	1	0.0		
Fox Sparrow	++++	++++				2	0	3	++++		
Song Sparrow		-100.0	-100.0	50.0	++++	4	24	32	33.3	27.6	
Lincoln's Sparrow	50.0	25.0	66.7	33.3		4	35	52	48.6	14.3	**
Dark-eyed Junco	375.0	78.6	100.0	112.5		4	45	99	120.0	31.7	**

Table 5. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	All five stations combined: n[1]	Number of young: 2003	Number of young: 2004	Percent change	SE[2]	
Black-headed Grosbeak			-100.0	++++	187.5	3	9	27	200.0	69.4	
Lazuli Bunting			++++		-76.9	2	13	5	-61.5	30.8	
Red-winged Blackbird				++++		1	0	1	++++		
Brewer's Blackbird			++++			1	0	1	++++		
Brown-headed Cowbird						0	0	0			
Bullock's Oriole						0	0	0			
Pine Grosbeak	++++					1	0	1	++++		
Purple Finch				-100.0	3000.0	2	2	31	1450.0	1550.0	
Cassin's Finch		-100.0			++++	2	1	2	100.0	400.0	
House Finch				-100.0		1	1	0	-100.0		
Pine Siskin		100.0		++++		2	3	8	166.7	133.3	
Lesser Goldfinch		++++			++++	2	0	3	++++		
Evening Grosbeak					-100.0	1	1	0	-100.0		
ALL SPECIES POOLED	425.0	100.0	192.7	97.7	157.1	5	341	806	136.4	25.1	***
No. species that increased[4]	13(10)	17(10)	21(11)	23(9)	16(8)				38(12)		
No. species that decreased[5]	0(0)	6(3)	4(3)	8(7)	6(3)				12(6)		
No. species remained same	0	2	2	4	2				3		
Total Number of Species	13	25	27	35	24				53		
Proportion of increasing (decreasing) species	1.000	0.680	0.778	0.657	0.667				0.717		
Sig. of increase (decrease)[6]	0.000 ***	0.054 *	0.003 ***	0.045 **	0.076 *				0.001 ***		

Table 5. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

[1] Number of stations lying within the breeding range of the species at which at least one individual young bird of the species was captured in either year.
[2] Standard error of the percent change in the number of individual young captured.
[3] Increase indeterminate (infinite) because no young bird was captured during 2003.
[4] No. of species for which young birds were captured in 2004 but not in 2003 are in parentheses.
[5] No. of species for which young birds were captured in 2003 but not in 2004 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 6. Changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

							All five stations combined				
							Reproductive Index				
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Change	SE[2]	
Acorn Woodpecker					+-+-+[3]	1	0.000	und.[4]	+-+-+[3]		
Williamson's Sapsucker	0.333					1	0.000	0.333	0.333		
Red-breasted Sapsucker	0.000	0.667	-0.667	0.063	3.000	5	0.133	0.440	0.307	0.187	
Downy Woodpecker				+-+-+[3]	+-+-+	2	0.333	0.000	-0.333	0.667	
Hairy Woodpecker	+-+-+[3]	2.000	+-+-+[3]	+-+-+	+-+-+	5	0.333	3.000	2.667	1.639	
White-headed Woodpecker		+-+-+[3]	0.667	+-+-+	1.000	4	0.000	0.750	0.750	0.102	***
Northern Flicker	+-+-+	0.000	+-+-+	0.000	1.000	5	0.000	0.200	0.200	0.200	
Olive-sided Flycatcher				+-+-+		1	0.000	und.	+-+-+		
Western Wood-Pewee	+-+-+	+-+-+	+-+-+	-0.667	0.000	5	0.111	0.400	0.289	0.318	
"Traill's" Flycatcher					0.000	1	0.000	0.000	0.000		
Hammond's Flycatcher	+-+-+	0.000	1.750	+-+-+		4	1.750	4.000	2.250	2.151	
Dusky Flycatcher	+-+-+	0.167	0.000	-0.333		4	0.095	0.059	-0.036	0.120	
"Western" Flycatcher	+-+-+	+-+-+	0.714	1.125		4	0.286	1.188	0.902	0.406	
Black Phoebe		+-+-+	+-+-+	+-+-+	2.500	4	0.429	2.667	2.238	1.312	
Cassin's Vireo		0.000	1.000	-0.083		3	0.500	0.667	0.167	0.315	
Hutton's Vireo			+-+-+			1	und.[4]	und.	+-+-+		
Warbling Vireo	+-+-+	0.000	0.055	0.299	-0.500	5	0.265	0.385	0.120	0.140	
Steller's Jay			+-+-+	-1.000	+-+-+	3	0.500	0.000	-0.500	0.433	
Western Scrub-Jay					+-+-+	1	und.	0.000	+-+-+		
Mountain Chickadee	1.000	0.103	7.000	0.500		4	0.261	1.118	0.857	0.563	
Chestnut-backed Chickadee				+-+-+		1	1.000	und.	+-+-+		
Bushtit				+-+-+	-1.636	2	2.000	1.091	-0.909	1.455	
Red-breasted Nuthatch	+-+-+	-1.167	+-+-+	4.000		4	2.667	3.714	1.048	2.132	
White-breasted Nuthatch		+-+-+			0.000	2	0.000	0.000	0.000	0.000	

Table 6. (cont.) Changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

							All five stations combined				
							Reproductive Index				
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Change	SE[2]	
Brown Creeper	+-+-+	-0.083	0.250	1.000	1.000	5	1.600	2.625	1.025	1.161	
Bewick's Wren					+-+-+	1	und.	1.000	+-+-+		
House Wren					+-+-+	1	und.	0.500	+-+-+		
Winter Wren				+-+-+		1	und.	und.	+-+-+		
Golden-crowned Kinglet	0.000	-10.333	1.700	+-+-+		4	3.083	2.556	-0.528	3.172	
Townsend's Solitaire		+-+-+				1	und.	und.	+-+-+		
Hermit Thrush	0.000	+-+-+	0.000	-0.500	+-+-+	5	0.125	0.000	-0.125	0.124	
American Robin	0.000	0.133	+-+-+	-0.100	0.000	5	0.111	0.364	0.253	0.153	
Wrentit					-0.333	1	0.667	0.333	-0.333		
Nashville Warbler				3.500	0.333	2	0.600	1.500	0.900	0.837	
Yellow Warbler			+-+-+	-0.333	-0.214	3	0.750	0.400	-0.350	0.318	
Yellow-rumped Warbler	0.100	3.467	1.137	-0.200	0.000	5	0.905	2.797	1.892	1.192	
Black-throated Gray Warb.		+-+-+	+-+-+	+-+-+	+-+-+	4	und.	9.000	+-+-+		
Hermit Warbler	1.000	4.500	4.457	0.688		4	0.080	3.200	3.120	1.174	*
MacGillivray's Warbler		-0.056	-0.188	-0.017	1.333	4	0.733	0.738	0.004	0.113	
Wilson's Warbler	+-+-+	+-+-+	+-+-+	+-+-+	+-+-+	5	und.	und.	+-+-+		
Western Tanager		0.150	+-+-+	0.833	0.000	4	0.235	0.800	0.565	0.592	
Green-tailed Towhee		0.000	+-+-+		+-+-+	3	0.000	0.000	0.000	0.000	
Spotted Towhee				-0.500	1.400	2	0.167	0.857	0.690	0.743	
Chipping Sparrow	+-+-+		0.167	+-+-+		3	0.100	0.333	0.233		
Fox Sparrow	+-+-+	+-+-+	+-+-+			3	0.000	und.	+-+-+		
Song Sparrow		+-+-+	+-+-+	0.364	0.667	4	1.143	1.280	0.137	0.271	
Lincoln's Sparrow	+-+-+	-0.359	0.078	0.100		4	0.897	0.722	-0.175	0.375	
Dark-eyed Junco	0.252	0.413	0.058	0.273	+-+-+	5	0.592	0.739	0.147	0.162	

Table 6. (cont.) Changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

							All five stations combined				
							Reproductive Index				
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2003	2004	Change	SE[2]	
Black-headed Grosbeak			+-+-+	0.444	6.333	3	0.563	2.250	1.688	2.412	
Lazuli Bunting		+-+-+	2.000		2.000	3	0.619	2.500	1.881	0.580	*
Red-winged Blackbird				+-+-+		1	0.000	und.	+-+-+		
Brewer's Blackbird			+-+-+	+-+-+	0.000	3	0.000	1.000	1.000	1.732	
Brown-headed Cowbird				+-+-+	+-+-+	2	0.000	0.000	0.000	0.000	
Bullock's Oriole					+-+-+	1	und.	0.000	+-+-+		
Pine Grosbeak	+-+-+					1	0.000	und.	+-+-+		
Purple Finch			+-+-+	-0.111	15.375	3	0.118	7.750	7.632	5.813	
Cassin's Finch	0.000	-1.000	0.000	+-+-+	+-+-+	5	0.167	0.500	0.333	0.681	
House Finch				+-+-+		1	und.	und.	+-+-+		
Pine Siskin		0.000	+-+-+	+-+-+		3	0.429	0.727	0.299	0.348	
Lesser Goldfinch		0.500			1.000	2	0.000	0.750	0.750	0.250	
Evening Grosbeak					+-+-+	1	1.000	und.	+-+-+		
ALL SPECIES POOLED	0.464	0.520	0.754	0.472	0.917	5	0.561	1.198	0.637	0.180	**
No. species that increased	5	10	14	13	13				31		
No. species that decreased	0	6	2	11	4				9		
No. species remained same	5	6	3	1	7				4		
Total Number of Species[5]	10	22	19	25	24				44		
Proportion of increasing (decreasing) species	0.500	0.455	0.737	0.520	0.542				0.705		
Sig. of increase (decrease)[6]	0.623	0.738	0.032 *	0.500	0.419				0.005 ***		

Table 6. (cont.) Changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

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[1] Number of stations lying within the breeding range of the species at which at least one individual aged bird of the species was captured in either year.
[2] Standard error of the change in the reproductive index.
[3] The change in reproductive index is undefined at this station because no adult individual of the species was captured in one of the two years.
[4] Reproductive index not given because no adult individual of the species was captured in the year shown.
[5] Species for which the change in the reproductive index is undefined are not included.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 \le P < 0.05$; * $0.05 \le P < 0.10$

Table 7. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 12 years, 1993-2004 (1998-2004 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 15 years, 1990-2004. Data for each species are included only from stations that lie within the breeding range of the species.

	White Wolf			Gin Flat E. Mead. (1998-2004)			Crane Flat			Hodgdon Meadow (1993-2004)			Big Meadow			All stations pooled (1993-2004)[1,3]			Hodgdon Meadow (1990-2004)		
Species	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
Sharp-shinned Hawk				0.2	0.0	0.00										*0.0*	*0.0*	*0.00*			
Belted Kingfisher													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Acorn Woodpecker													0.9	0.0	0.00	0.2	0.0	0.00			
Williamson's Sapsucker	5.4	0.8	0.15	0.0	0.2	und.[4]										0.9	0.2	0.15			
Red-breasted Sapsucker	0.8	0.5	0.25	5.6	3.7	0.98	2.2	0.6	0.28	7.2	3.4	0.61	1.4	0.7	0.71	3.6	1.7	0.52	6.3	3.0	0.58
Downy Woodpecker										0.5	0.2	0.00	1.9	0.8	0.23	0.6	0.2	0.27	0.4	0.1	0.00
Hairy Woodpecker	0.1	0.1	0.00	0.7	0.4	0.67	0.8	0.1	0.00	0.2	0.7	0.50	2.2	0.9	0.32	0.8	0.5	0.93	0.2	0.6	0.63
White-headed Woodp.				1.2	0.5	0.50	1.0	0.2	0.11	0.7	0.1	0.00	0.8	0.1	0.25	0.7	0.1	0.17	0.6	0.1	0.00
Northern Flicker	0.3	0.2	0.00	0.4	0.0	0.00	0.4	0.1	0.33	1.0	0.4	0.50	2.2	0.2	0.18	0.9	0.2	0.20	0.8	0.3	0.45
Olive-sided Flycatcher				0.5	0.0	0.00				0.6	0.0	0.00	0.2	0.0	0.00	0.3	0.0	0.00	0.5	0.0	0.00
Western Wood-Pewee	1.3	0.3	0.00	1.1	0.4	0.00	0.0	0.1	und.[4]	3.7	0.8	0.28	5.9	0.8	0.12	2.8	0.5	0.24	3.4	0.7	0.24
"Traill's" Flycatcher							0.5	0.1	0.00	1.7	0.6	0.41	1.2	0.0	0.00	0.9	0.2	0.23	1.6	0.5	0.34
Hammond's Flycatcher	0.0	2.4	und.[4]	1.8	10.4	7.88	3.1	1.7	0.87	1.7	0.9	0.48	0.2	0.1	0.50	1.5	2.1	2.19	1.6	0.7	0.39
Dusky Flycatcher	1.9	0.3	0.04	4.1	1.5	0.38	17.7	2.3	0.13	14.9	2.0	0.13	1.4	0.1	0.00	9.7	1.3	0.16	13.8	2.0	0.14
"Western" Flycatcher	0.3	0.1	0.50	0.2	0.9	0.00	3.4	1.9	0.40	4.5	3.7	1.16	0.5	0.3	0.25	2.3	1.7	0.78	3.8	3.1	1.09
Black Phoebe				0.0	0.4	und.	0.1	0.1	0.00	0.2	0.7	0.33	5.7	7.2	2.07	1.3	1.8	2.40	0.2	0.6	0.33
Western Kingbird													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Cassin's Vireo	0.0	0.4	und.	0.7	0.2	0.00	1.5	0.3	0.21	4.9	3.1	0.67	1.1	0.1	0.14	2.2	1.2	0.55	4.3	2.8	0.71
Hutton's Vireo							0.0	0.1	und.							*0.0*	*0.0*	*0.00*			
Warbling Vireo	2.7	0.3	0.06	2.2	0.2	0.00	16.8	1.5	0.08	24.5	11.5	0.54	8.6	1.1	0.14	13.9	4.2	0.32	21.9	10.1	0.53
Steller's Jay	0.1	0.0	0.00	0.2	0.2	0.00	0.1	0.0	0.00	1.3	0.2	0.22	0.3	0.1	0.00	0.5	0.1	0.28	1.0	0.1	0.22
Western Scrub-Jay													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Tree Swallow													0.0	0.1		*0.0*	*0.0*	*0.00*			
N. Rough-winged Swal.													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Mountain Chickadee	5.3	2.8	0.61	11.7	10.3	1.22	5.2	4.4	1.67	1.1	0.4	0.44	0.2	0.0	0.00	3.6	2.5	0.87	1.0	0.4	0.45
Chestnut-backed Chick.	0.0	0.1	und.				0.0	0.1	und.	0.7	0.4	0.17				0.2	0.2	0.33	0.6	0.3	0.17
Oak Titmouse													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 12 years, 1993-2004 (1998-2004 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 15 years, 1990-2004. Data for each species are included only from stations that lie within the breeding range of the species.

	White Wolf			Gin Flat E. Mead. (1998-2004)			Crane Flat			Hodgdon Meadow (1993-2004)			Big Meadow			All stations pooled (1993-2004)[1,3]			Hodgdon Meadow (1990-2004)		
Species	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
Bushtit										0.8	2.6	3.00	3.2	5.1	2.93	0.9	1.8	2.62	0.7	2.1	3.00
Red-breasted Nuthatch	0.3	1.5	1.00	2.1	11.1	3.21	4.7	5.8	1.70	0.8	1.4	0.83				1.5	3.0	2.29	0.7	1.2	0.86
White-breasted Nuthatch				0.2	0.0	0.00				0.0	0.1	und.[4]	1.1	0.1	0.00	0.2	0.0	0.00	0.0	0.1	und.[4]
Brown Creeper	3.5	5.7	1.60	3.6	4.0	1.44	3.7	6.3	2.72	0.7	2.8	3.07	2.1	2.2	1.33	2.4	4.0	2.06	0.9	2.5	2.56
Bewick's Wren													1.5	1.1	0.81	0.3	0.2	0.81			
House Wren													5.1	6.8	1.81	1.1	1.5	1.81			
Winter Wren	0.0	0.1	und.				0.2	0.6	0.50	0.2	1.0	1.50	0.3	0.1	0.50	0.2	0.5	1.11	0.2	0.8	1.33
American Dipper													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Golden-crowned Kinglet	2.0	7.7	2.05	4.9	24.1	4.69	15.9	22.2	1.39	1.6	2.8	1.11				4.8	9.6	2.09	1.3	2.3	0.99
Ruby-crowned Kinglet	0.8	0.0	0.00													0.1	0.0	0.00			
Western Bluebird													2.2	0.7	0.09	0.5	0.1	0.09			
Townsend's Solitaire				0.0	0.2	und.				0.2	0.4	0.00				0.0	0.1	0.00	0.1	0.3	0.00
Swainson's Thrush										0.3	0.0	0.00				0.1	0.0	0.00	0.2	0.0	0.00
Hermit Thrush	1.9	0.2	0.11	0.5	0.0	0.00	4.0	0.6	0.23	1.6	0.6	0.47	0.2	0.0	0.00	1.8	0.4	0.28	1.4	0.6	0.42
American Robin	6.7	0.9	0.09	5.6	1.8	0.36	2.7	0.1	0.00	3.5	1.0	0.48	4.1	0.4	0.13	4.2	0.7	0.20	3.1	0.8	0.39
Wrentit													1.6	0.9	0.75	0.3	0.2	0.75			
Nashville Warbler										5.8	12.6	2.03	4.1	7.5	2.81	2.6	5.5	1.70	5.1	11.1	2.43
Yellow Warbler							1.3	0.2	0.04	4.9	1.9	0.78	7.3	5.1	1.10	3.4	1.7	0.61	4.6	1.9	0.78
Yellow-rumped Warbler	24.7	24.6	0.92	35.1	123.0	3.68	30.6	21.9	0.74	4.9	2.8	0.61	1.6	0.0	0.00	15.7	22.0	1.24	4.5	2.3	0.51
Blk.-throated Gray Warb.	0.0	0.2	und.	0.0	0.9	und.	0.0	1.4	und.	0.1	2.0	5.00	0.1	0.8	1.00	0.0	1.2	9.00	0.2	1.8	3.50
Hermit Warbler	2.3	10.2	3.60	3.3	14.0	2.42	21.9	21.7	1.15	9.7	9.6	1.59	0.1	0.0	0.00	8.5	10.6	1.36	8.5	7.9	1.34
MacGillivray's Warbler	0.0	0.8	und.	7.4	4.1	0.47	14.6	10.6	0.70	33.3	19.8	0.60	7.9	9.4	1.92	16.0	11.1	0.72	29.0	17.2	0.60
Wilson's Warbler	0.0	0.9	und.	0.2	2.4	1.00	1.7	4.1	2.42	3.3	1.2	0.51	1.1	0.8	0.48	1.8	1.8	1.27	2.9	1.1	0.56
Western Tanager	0.6	0.4	0.17	11.3	5.9	0.43	3.0	0.7	0.12	5.1	3.1	0.53	3.5	0.0	0.00	4.2	1.8	0.42	4.3	2.6	0.53
Green-tailed Towhee				0.9	0.0	0.00	0.3	0.0	0.00	0.0	0.1	und.	0.1	0.1	0.00	0.2	0.1	0.00	0.0	0.1	und.
Spotted Towhee										0.6	0.2	0.13	6.9	1.9	0.29	1.5	0.4	0.24	0.5	0.2	0.13
Chipping Sparrow	1.0	0.0	0.00	0.7	0.2	0.00	5.5	0.7	0.14	3.5	0.9	0.20	9.6	3.2	0.54	4.8	1.1	0.32	3.1	0.7	0.17

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	White Wolf			Gin Flat E. Mead. (1998-2004)			Crane Flat			Hodgdon Meadow (1993-2004)			Big Meadow			All stations pooled (1993-2004)[1,3]			Hodgdon Meadow (1990-2004)		
Species	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
Chipping Sparrow	1.0	0.0	0.00	0.7	0.2	0.00	5.5	0.7	0.14	3.5	0.9	0.20	9.6	3.2	0.54	4.8	1.1	0.32	3.1	0.7	0.17
Sage Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Fox Sparrow	0.0	0.1	und.	1.2	0.4	0.00	0.3	0.1	0.50	0.1	0.0	0.00	0.1	0.1	0.00	0.2	0.1	0.20	0.1	0.0	0.00
Song Sparrow	0.3	0.0	0.00	0.0	1.5	und.	2.1	2.4	1.08	21.7	23.9	1.13	6.2	4.0	0.59	8.6	8.9	1.08	18.0	19.6	1.10
Lincoln's Sparrow	5.0	2.6	0.36	26.3	13.7	0.57	26.9	27.7	1.04	17.8	10.6	0.61	1.1	1.8	1.45	15.1	11.7	0.79	15.0	8.9	0.60
Dark-eyed Junco	39.3	28.1	0.79	31.6	29.7	0.93	57.0	57.5	0.98	16.5	20.8	1.29	3.8	2.1	0.66	27.8	27.3	0.97	13.9	17.2	1.32
Black-headed Grosbeak	0.3	0.1	0.50	0.4	0.5	0.50	0.6	0.3	0.40	12.0	2.2	0.24	11.6	6.6	1.32	6.6	2.1	0.54	10.1	1.7	0.20
Lazuli Bunting	0.0	0.3	und.	0.2	0.0	0.00	7.2	1.0	0.28	0.6	0.2	0.17	34.9	16.0	0.57	9.6	3.9	0.49	0.5	0.1	0.11
Red-winged Blackbird										3.0	0.2	0.04				0.9	0.1	0.04	2.4	0.2	0.04
Brewer's Blackbird	0.8	0.1	0.17	0.0	0.2	und.	0.0	0.1	und.	0.7	0.0	0.00	3.1	0.2	0.04	1.0	0.1	0.14	0.6	0.0	0.00
Brown-headed Cowbird				0.2	0.0	0.00	0.1	0.0	0.00	0.3	0.0	0.00	0.8	0.2	0.13	0.3	0.0	0.05	0.3	0.0	0.00
Bullock's Oriole													2.4	0.1	0.07	0.5	0.0	0.07			
Pine Grosbeak	4.5	0.1	0.00													0.7	0.0	0.00			
Purple Finch	0.5	0.3	0.00	1.1	0.0	0.00	6.9	2.4	0.39	11.0	2.7	0.25	9.7	9.5	1.26	7.2	3.3	0.83	11.0	2.9	0.27
Cassin's Finch	13.0	0.7	0.04	2.4	0.7	0.28	2.3	0.2	0.06	1.7	0.3	0.07	0.9	0.4	0.25	3.5	0.4	0.15	1.5	0.3	0.10
House Finch							0.1	0.0	0.00	0.0	0.2	und.				0.0	0.1	0.00	0.0	0.1	und.
Red Crossbill	0.1	0.0	0.00							0.6	0.2	0.25	0.2	0.0	0.00	0.2	0.0	0.10	0.5	0.1	0.25
Pine Siskin	6.3	0.8	0.11	8.1	17.2	5.76	4.8	0.2	0.06	2.0	0.9	0.23	0.7	0.2	0.11	3.8	2.2	0.62	1.8	0.7	0.17
Lesser Goldfinch				1.8	2.7	1.38	0.6	0.4	1.00	0.6	0.2	0.22	12.2	6.9	0.65	3.1	1.9	0.73	0.5	0.2	0.22
Lawrence's Goldfinch				0.2	0.2	1.00							2.3	0.1	0.00	0.5	0.0	0.02	0.1	0.0	0.00
Evening Grosbeak	0.4	0.0	0.00							0.1	0.0	0.00	1.5	0.3	0.17	0.4	0.1	0.17	0.1	0.0	0.00
House Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
ALL SPECIES POOLED	132.4	95.0	0.75	180.1	287.7	1.58	271.9	202.8	0.74	238.9	158.0	0.66	190.8	107.6	0.62	214.5	160.4	0.76	209.5	134.9	0.63
Number of Species	31	34		38	35		39	40		51	48		62	46		69	56		52	48	
Total Number of Species		40			44			44			54			63			75			55	

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 12 years, 1993-2004 (1998-2004 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 15 years, 1990-2004. Data for each species are included only from stations that lie within the breeding range of the species.

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[1] Analysis of all stations pooled include data from 1993-2004 from the White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow stations as well as data from 1998-2004 from the Gin Flat East Meadow station.

[2] Years for which the reproductive index was undefined (no adult birds were captured in the year) are not included in the mean reproductive index.

[3] For numbers presented in italics, the mean number of adults or young is greater than 0.1 at one or more stations, but over the entire location the mean number is less than 0.05. The species is counted in the number of species over all stations pooled.

[4] The reproductive index is undefined at this station because no young individual of the species was ever captured in the same year as an adult individual of the species.

Table 8. Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents from transient models using 12 years (1993-2004) of mark-recapture data from the five currently operating MAPS stations in Yosemite National Park. $QAIC_C$[1] and (GOF)[2] are presented for all models.

	Transient Models								
Species	$\phi p \tau$ [3]	$\phi_t p \tau$ [4]	$\phi p_t \tau$ [5]	$\phi p \tau_t$ [6]	$\phi_t p_t \tau$ [7]	$\phi_t p \tau_t$ [8]	$\phi p_t \tau_t$ [9]	$\phi_t p_t \tau_t$ [10]	$\Delta QAIC_C$
Williamson's Sapsucker	45.1* (1.000)	75.2 (1.000)	68.1 (1.000)	74.5 (1.000)	162.5 (1.000)	192.5 (1.000)	183.4 (1.000)	2058.0 (1.000)	30.0
Red-breasted Sapsucker	67.2* (1.000)	87.9 (1.000)	83.7 (1.000)	80.7 (1.000)	99.0 (1.000)	105.8 (1.000)	100.5 (1.000)	121.0 (1.000)	20.7
Hairy Woodpecker	36.9* (1.000)	67.7 (1.000)	63.7 (1.000)	67.6 (1.000)	184.4 (1.000)	215.8 (1.000)	209.4 (1.000)	n/a	30.9
Northern Flicker	30.5* (1.000)	61.8 (1.000)	62.1 (1.000)	60.5 (1.000)	157.3 (1.000)	179.1 (1.000)	177.8 (1.000)	2052.0 (1.000)	31.3
Western Wood-Pewee	79.7* (1.000)	95.1 (1.000)	94.2 (1.000)	85.4 (1.000)	115.4 (1.000)	109.3 (1.000)	106.7 (1.000)	132.3 (1.000)	15.4
Hammond's Flycatcher	19.4* (1.000)	41.6 (1.000)	41.0 (1.000)	44.1 (1.000)	80.7 (1.000)	88.5 (1.000)	86.3 (1.000)	155.4 (1.000)	22.2
Dusky Flycatcher	128.1* (1.000)	137.6 (1.000)	136.8 (1.000)	132.4 (1.000)	149.5 (1.000)	146.9 (1.000)	143.1 (1.000)	157.2 (1.000)	9.5
Black Phoebe	39.4* (1.000)	59.0 (1.000)	58.6 (1.000)	56.3 (1.000)	107.5 (1.000)	111.3 (1.000)	109.2 (1.000)	222.6 (1.000)	19.7
Cassin's Vireo	28.6* (1.000)	44.6 (1.000)	46.4 (1.000)	45.8 (1.000)	86.7 (1.000)	75.9 (1.000)	74.1 (1.000)	127.2 (1.000)	16.0

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents from transient models using 12 years (1993-2004) of mark-recapture data from the five currently operating MAPS stations in Yosemite National Park. $QAIC_C$[1] and (GOF)[2] are presented for all models.

	Transient Models								
Species	$\phi p \tau$[3]	$\phi_t p \tau$[4]	$\phi p_t \tau$[5]	$\phi p \tau_t$[6]	$\phi_t p_t \tau$[7]	$\phi_t p \tau_t$[8]	$\phi p_t \tau_t$[9]	$\phi_t p_t \tau_t$[10]	$\Delta QAIC_C$
Warbling Vireo	155.6 (1.000)	173.7 (0.999)	165.1 (1.000)	152.3* (1.000)	166.3 (1.000)	160.9 (1.000)	164.5 (1.000)	162.2 (1.000)	18.1
Mountain Chickadee	47.0* (1.000)	54.1 (1.000)	56.8 (1.000)	61.9 (1.000)	76.5 (1.000)	81.0 (1.000)	82.0 (1.000)	104.2 (1.000)	7.1
Brown Creeper	48.2* (1.000)	60.0 (1.000)	62.1 (1.000)	62.6 (1.000)	84.7 (1.000)	86.5 (1.000)	87.5 (1.000)	117.1 (1.000)	11.7
Golden-crowned Kinglet	39.1* (1.000)	53.1 (1.000)	52.1 (1.000)	55.1 (1.000)	70.8 (1.000)	69.1 (1.000)	69.3 (1.000)	92.8 (1.000)	14.0
Hermit Thrush	35.7* (1.000)	52.1 (1.000)	54.6 (1.000)	52.4 (1.000)	85.9 (1.000)	89.7 (1.000)	90.3 (1.000)	140.1 (1.000)	16.4
American Robin	112.5* (1.000)	126.7 (1.000)	129.0 (1.000)	123.0 (1.000)	146.4 (1.000)	141.9 (1.000)	143.7 (1.000)	162.7 (1.000)	14.2
Yellow Warbler	99.6* (1.000)	115.4 (1.000)	111.8 (1.000)	111.3 (1.000)	127.2 (1.000)	129.8 (1.000)	127.5 (1.000)	143.0 (1.000)	15.8
Yellow-rumped Warbler	108.3* (1.000)	116.7 (1.000)	120.4 (1.000)	119.7 (1.000)	127.0 (1.000)	128.5 (1.000)	131.8 (1.000)	141.7 (1.000)	8.4
Hermit Warbler	88.1* (1.000)	100.4 (1.000)	98.6 (1.000)	95.1 (1.000)	107.8 (1.000)	112.0 (1.000)	105.2 (1.000)	120.8 (1.000)	12.3

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents from transient models using 12 years (1993-2004) of mark-recapture data from the five currently operating MAPS stations in Yosemite National Park. $QAIC_C$[1] and (GOF)[2] are presented for all models.

	Transient Models								
Species	$\phi p \tau$ [3]	$\phi_t p \tau$ [4]	$\phi p_t \tau$ [5]	$\phi p \tau_t$ [6]	$\phi_t p_t \tau$ [7]	$\phi_t p \tau_t$ [8]	$\phi p_t \tau_t$ [9]	$\phi_t p_t \tau_t$ [10]	$\Delta QAIC_C$
MacGillivray's Warbler	173.0* (1.000)	185.8 (1.000)	188.8 (1.000)	189.2 (1.000)	200.8 (1.000)	202.2 (1.000)	205.7 (1.000)	219.4 (1.000)	12.8
Western Tanager	33.0* (1.000)	44.4 (1.000)	43.8 (1.000)	44.7 (1.000)	91.3 (n/a)	65.6 (1.000)	62.8 (1.000)	116.2 (n/a)	11.4
Spotted Towhee	33.4* (1.000)	53.8 (1.000)	56.1 (1.000)	54.2 (1.000)	92.3 (1.000)	96.6 (1.000)	97.0 (1.000)	163.7 (1.000)	20.4
Chipping Sparrow	83.7* (1.000)	97.8 (1.000)	99.3 (1.000)	101.2 (1.000)	109.9 (1.000)	117.7 (1.000)	116.6 (1.000)	128.2 (1.000)	14.1
Song Sparrow	166.8* (1.000)	175.7 (1.000)	173.6 (1.000)	178.4 (1.000)	187.1 (1.000)	189.5 (1.000)	190.4 (1.000)	202.9 (1.000)	8.9
Lincoln's Sparrow	201.8 (0.994)	199.4* (1.000)	199.0* (1.000)	211.3 (0.997)	204.3 (1.000)	216.4 (1.000)	212.4 (1.000)	221.7 (1.000)	-2.4
Dark-eyed Junco	236.8 (0.982)	233.6* (1.000)	236.1 (0.999)	247.7 (0.984)	246.3 (0.999)	250.1 (0.999)	251.7 (0.998)	261.4 (0.998)	-3.2
Black-headed Grosbeak	118.3* (1.000)	127.6 (1.000)	129.5 (1.000)	122.0 (1.000)	142.5 (1.000)	139.3 (1.000)	139.7 (1.000)	153.5 (1.000)	9.3
Lazuli Bunting	107.4* (1.000)	116.5 (1.000)	113.7 (1.000)	118.7 (1.000)	127.4 (1.000)	133.8 (1.000)	129.2 (1.000)	143.5 (1.000)	9.1

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents from transient models using 12 years (1993-2004) of mark-recapture data from the five currently operating MAPS stations in Yosemite National Park. $QAIC_C$[1] and (GOF)[2] are presented for all models.

Species	Transient Models $\phi p \tau$[3]	$\phi_t p \tau$[4]	$\phi p_t \tau$[5]	$\phi p \tau_t$[6]	$\phi_t p_t \tau$[7]	$\phi_t p \tau_t$[8]	$\phi p_t \tau_t$[9]	$\phi_t p_t \tau_t$[10]	$\Delta QAIC_C$
Red-winged Blackbird	25.2* (1.000)	51.7 (1.000)	49.5 (1.000)	53.4 (1.000)	115.2 (1.000)	130.2 (1.000)	126.4 (1.000)	351.7 (1.000)	26.6
Purple Finch	45.7* (1.000)	57.0 (1.000)	54.1 (1.000)	57.5 (1.000)	70.6 (1.000)	89.9 (1.000)	72.1 (1.000)	90.0 (1.000)	11.3
Cassin's Finch	28.8* (1.000)	48.7 (1.000)	44.2 (1.000)	45.1 (1.000)	79.9 (n/a)	84.4 (1.000)	66.8 (1.000)	128.6 (n/a)	19.8

1 Akaike Information Criterion ($QAIC_C$) given as -2(log-likelihood) + 2(number of estimable parameters) with corrections for small sample sizes and overdispersion of data.

[2] Goodness-of-fit is a measure of how well the actual distribution of data fits the theoretical distribution calculated using the estimates provided by the model. The larger the value provided by the GOF test the better the model describes the data.

[3] $\phi p \tau$ Model: Transient model with temporally-constant survival probability, recapture probability, and proportion of residents (invariable from year to year).

[4] $\phi_t p \tau$ Model: Transient model with temporally-variable survival probability; and temporally-constant recapture probability and proportion of residents.

[5] $\phi p_t \tau$ Model: Transient model with temporally-variable recapture probability; and temporally-constant survival probability and proportion of residents.

[6] $\phi p \tau_t$ Model: Transient model with temporally-variable proportion of residents; and temporally-constant survival and recapture probabilities.

[7] $\phi_t p_t \tau$ Model: Transient model with temporally-variable survival and recapture probabilities; and temporally-constant proportion of residents.

[8] $\phi_t p \tau_t$ Model: Transient model with temporally-variable survival probability and proportion of residents; and temporally-constant recapture probability.

[9] $\phi p_t \tau_t$ Model: Transient model with temporally-variable recapture probability and proportion of residents; and temporally-constant survival probability.

[10] $\phi_t p_t \tau_t$ Model: Transient model with temporally-variable survival probability, recapture probability, and proportion of residents.

[11] $\Delta QAIC_C$ is defined as the difference in $\Delta QAIC_C$ between the $\phi p \tau$ model and the $\phi_t p \tau$ model.

* The chosen models are the model with the lowest $QAIC_C$ and the models with $QAIC_C$s within 2.0 units of the model with the lowest $QAIC_C$.

Table 9. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

Species	Num. sta2.[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Model[5]	$QAIC_C$[6]	Survival probability[7]	Surv. C.V.[8]	Recapture probability[9]	Proportion of residents[10]
Williamson's Sapsucker †	1	31	41	5	$\phi p \tau$	45.1	0.715 (0.168)	23.5	0.084 (0.084)	1.000 (1.014)
Red-breasted Sapsucker	3	118	159	16	$\phi p \tau$	67.2	0.464 (0.111)	24.0	0.231 (0.116)	0.895 (0.476)
Hairy Woodpecker ‡	5	28	34	4	$\phi p \tau$	36.9	0.658 (0.183)	27.8	0.120 (0.125)	0.780 (0.820)
Northern Flicker ‡†	5	34	39	4	$\phi p \tau$	30.5	0.474 (0.251)	52.9	0.171 (0.259)	1.000 (1.720)
Western Wood-Pewee	4	98	134	14	$\phi p \tau$	79.7	0.652 (0.098)	15.1	0.182 (0.081)	0.442 (0.217)
Hammond's Flycatcher ‡	3	54	61	2	$\phi p \tau$	19.4	0.542 (0.314)	58.0	0.256 (0.283)	0.096 (0.128)
Dusky Flycatcher	4	309	492	57	$\phi p \tau$	128.1	0.405 (0.051)	12.5	0.478 (0.085)	0.527 (0.126)
Black Phoebe	1	41	56	7	$\phi p \tau$	39.4	0.460 (0.168)	36.4	0.704 (0.243)	0.296 (0.194)
Cassin's Vireo ‡†	3	81	88	3	$\phi p \tau$	28.6	0.568 (0.228)	40.1	0.033 (0.076)	1.000 (2.266)
Warbling Vireo	5	497	720	57	$\phi p \tau$	155.6*	0.486 (0.052)	10.7	0.295 (0.062)	0.386 (0.095)
					$\phi p \tau_t$	152.3	0.478 (0.051)	10.7	0.305 (0.062)	a0.488 (0.224)
										b0.706 (0.293)
										c0.496 (0.250)
										d0.153 (0.153)
										e0.522 (0.238)
										f0.919 (0.333)
										g0.121 (0.122)
										h0.000 (0.764)
										i0.176 (0.176)
										j0.000 (0.912)
										k0.299 (0.298)

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

Species	Num. sta2.[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Model[5]	$QAIC_C$[6]	Survival probability[7]	Surv. C.V.[8]	Recapture probability[9]	Proportion of residents[10]
Mountain Chickadee †	5	139	167	13	$\phi p \tau$	47.0	0.242 (0.112)	46.4	0.348 (0.235)	1.000 (0.755)
Brown Creeper	5	88	113	9	$\phi p \tau$	48.2	0.412 (0.134)	32.4	0.331 (0.190)	0.465 (0.303)
Golden-crowned Kinglet	4	184	219	7	$\phi p \tau$	39.1	0.268 (0.124)	46.1	0.500 (0.292)	0.126 (0.093)
Hermit Thrush	3	63	74	5	$\phi p \tau$	35.7	0.445 (0.170)	38.3	0.313 (0.229)	0.297 (0.251)
American Robin †	5	148	195	24	$\phi p \tau$	112.5	0.629 (0.081)	12.9	0.126 (0.055)	1.000 (0.448)
Yellow Warbler	3	105	211	29	$\phi p \tau$	99.6	0.610 (0.068)	11.2	0.450 (0.093)	0.283 (0.106)
Yellow-rumped Warbler	4	605	706	42	$\phi p \tau$	108.3	0.365 (0.066)	18.1	0.266 (0.087)	0.499 (0.176)
Hermit Warbler	4	322	357	18	$\phi p \tau$	88.1	0.583 (0.094)	16.1	0.095 (0.056)	0.496 (0.297)
MacGillivray's Warbler	4	496	1081	151	$\phi p \tau$	173.0	0.529 (0.032)	6.1	0.642 (0.049)	0.354 (0.055)
Western Tanager ‡†	4	165	176	4	$\phi p \tau$	33.0	0.746 (0.209)	28.1	0.013 (0.032)	1.000 (2.530)
Spotted Towhee	1	50	64	8	$\phi p \tau$	33.4	0.432 (0.169)	39.2	0.685 (0.251)	0.335 (0.212)
Chipping Sparrow †	4	156	225	23	$\phi p \tau$	83.7	0.450 (0.081)	18.1	0.193 (0.083)	1.000 (0.455)
Song Sparrow	3	259	539	85	$\phi p \tau$	166.8	0.457 (0.044)	9.5	0.464 (0.066)	0.947 (0.176)

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

Species	Num. sta2.[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Model[5]	$QAIC_C$[6]	Survival probability[7]	Surv. C.V.[8]	Recapture probability[9]	Proportion of residents[10]
Lincoln's Sparrow	4	461	1181	147	$\phi p \tau$	201.8*	0.494 (0.032)	6.5	0.628 (0.051)	0.460 (0.072)
					$\phi_t p \tau$	199.4	a0.667 (0.170)	25.5	0.603 (0.053)	0.468 (0.072)
							b0.432 (0.109)	25.2		
							c0.265 (0.098)	37.0		
							d0.558 (0.128)	22.9		
							e0.379 (0.100)	26.4		
							f0.493 (0.103)	20.9		
							g0.666 (0.112)	16.8		
							h0.567 (0.101)	17.8		
							i0.402 (0.093)	23.1		
							j0.357 (0.082)	23.0		
							k0.977 (0.167)	17.1		
					$\phi p_t \tau$	199.0	0.502 (0.032)	6.4	a0.651 (0.195)	0.469 (0.073)
									b0.385 (0.120)	
									c0.219 (0.101)	
									d0.620 (0.130)	
									e0.318 (0.110)	
									f0.602 (0.116)	
									g0.688 (0.120)	
									h0.662 (0.112)	
									i0.739 (0.115)	
									j0.578 (0.119)	
									k1.000 (0.195)	

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

Species	Num. sta2.[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Model[5]	$QAIC_C$[6]	Survival probability[7]	Surv. C.V.[8]	Recapture probability[9]	Proportion of residents[10]
Dark-eyed Junco	5	904	1658	225	$\phi p \tau$	236.8*	0.475 (0.027)	5.7	0.513 (0.041)	0.574 (0.067)
					$\phi_t p \tau$	233.6	a0.441 (0.107)	24.3	0.503 (0.042)	0.592 (0.070)
							b0.314 (0.069)	22.0		
							c0.687 (0.116)	16.9		
							d0.543 (0.092)	16.9		
							e0.368 (0.080)	21.7		
							f0.372 (0.078)	21.0		
							g0.541 (0.099)	18.3		
							h0.317 (0.061)	19.2		
							i0.532 (0.091)	17.1		
							j0.610 (0.090)	14.8		
							k0.618 (0.110)	17.8		
Black-headed Grosbeak	3	218	278	33	$\phi p \tau$	118.3	0.574 (0.067)	11.7	0.278 (0.077)	0.433 (0.141)
Lazuli Bunting	2	332	407	25	$\phi p \tau$	107.4	0.621 (0.071)	11.4	0.171 (0.058)	0.239 (0.090)
Red-winged Blackbird ‡	1	35	43	4	$\phi p \tau$	25.2	0.332 (0.205)	61.8	0.343 (0.331)	0.653 (0.702)
Purple Finch ‡	4	275	300	11	$\phi p \tau$	45.7	0.212 (0.111)	52.4	0.233 (0.222)	0.659 (0.671)
Cassin's Finch ‡†	2	100	104	3	$\phi p \tau$	28.8	0.839 (0.245)	29.1	0.010 (0.030)	1.000 (3.080)

[1] Number of stations where the species was a regular or usual breeder and at which adults of the species were captured. Stations within one km of each other were combined into a single super-station to prevent individuals whose home ranges included portions of two or more stations from being counted as multiple individuals.
[2] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).
[3] Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.
[4] Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

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[5] Models included are those chosen by $QAIC_C$ (those models marked with * in Table 9) plus the $\phi p \tau$ model in all cases. See Table 9 for definitions of the models.

[6] Akaike Information Criterion ($QAIC_C$) given as -2(log-likelihood) + 2(number of estimable parameters) with corrections for small sample size and over dispersion of data.

[7] Survival probability (ϕ) presented as the maximum likelihood estimate (standard error of the estimate).

a The survival probability between the years 1992-1993 in a temporally variable model.
b The survival probability between the years 1993-1994 in a temporally variable model.
c The survival probability between the years 1994-1995 in a temporally variable model.
d The survival probability between the years 1995-1996 in a temporally variable model.
e The survival probability between the years 1996-1997 in a temporally variable model.
f The survival probability between the years 1997-1998 in a temporally variable model.
g The survival probability between the years 1998-1999 in a temporally variable model.
h The survival probability between the years 1999-2000 in a temporally variable model.
i The survival probability between the years 2000-2001 in a temporally variable model.
j The survival probability between the years 2001-2002 in a temporally variable model.
k The survival probability between the years 2002-2003 in a temporally variable model.

[8] The coefficient of variation for survival probability, CV(ϕ).

[9] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).

a The recapture probability in 1994 in a temporally variable model.
b The recapture probability in 1995 in a temporally variable model.
c The recapture probability in 1996 in a temporally variable model.
d The recapture probability in 1997 in a temporally variable model.
e The recapture probability in 1998 in a temporally variable model.
f The recapture probability in 1999 in a temporally variable model.
g The recapture probability in 2000 in a temporally variable model.
h The recapture probability in 2001 in a temporally variable model.
i The recapture probability in 2002 in a temporally variable model.
j The recapture probability in 2003 in a temporally variable model.
k The recapture probability in 2004 in a temporally variable model.

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at the five currently operating MAPS stations in Yosemite National Park obtained from 12 years (1993-2004) of mark-recapture data.

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[10] The proportion of residents among newly captured adults (τ) presented as the maximum likelihood estimate (standard error of the estimate).

a The proportion of residents in the adult population in 1993 in a temporally variable model.
b The proportion of residents in the adult population in 1994 in a temporally variable model.
c The proportion of residents in the adult population in 1995 in a temporally variable model.
d The proportion of residents in the adult population in 1996 in a temporally variable model.
e The proportion of residents in the adult population in 1997 in a temporally variable model.
f The proportion of residents in the adult population in 1998 in a temporally variable model.
g The proportion of residents in the adult population in 1999 in a temporally variable model.
h The proportion of residents in the adult population in 2000 in a temporally variable model.
i The proportion of residents in the adult population in 2001 in a temporally variable model.
j The proportion of residents in the adult population in 2002 in a temporally variable model.
k The proportion of residents in the adult population in 2003 in a temporally variable model.

* The time-constant model was not selected by $QAIC_C$, but is presented to allow the parameter values to be compared with other species.
‡ The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures, or the estimate is very imprecise ($SE(\phi)>0.200$ or $CV(\phi)>50.0\%$).
† The estimate for recapture probability (and possibly survival probability as well) may be biased low because the estimate for τ was 1.000.

Table 10. Assessment of vital rates for 14 target species showing substantially decreasing or increasing 12-year (1993-2004) population trends at the four long-running stations in Yosemite National Park.

Species	Trend and its significance[1]	Productivity	Survival Probability[2]
A. Decreasing Species			
Western Wood-Pewee	- 6.0 **	low, decreasing	high
Dusky Flycatcher	- 6.0 ***	low, decreasing	slightly low
Warbling Vireo	- 1.6	low, increasing	as expected
Golden-crowned Kinglet	- 6.1 **	high	low/high
Hermit Thrush	- 3.6	slightly low, decreasing	slightly low
Yellow Warbler	- 3.8 **	slightly low, increasing	high/as-expected
Hermit Warbler	- 4.3 **	high, increasing	high/as-expected
Chipping Sparrow	- 6.3 **	low, decreasing	as expected/high
Lincoln's Sparrow	- 3.0 *	as expected, increasing	as expected/high
Black-headed Grosbeak	- 5.7 ***	slightly high, increasing	as expected
Lazuli Bunting	- 8.1 ***	slightly low, increasing	high
B. Increasing Species			
Mountain Chickadee	5.6	as expected, increasing	low
Yellow-rumped Warbler	10.7 *	high	slightly low/low
MacGillivray's Warbler	1.9	as expected	slightly high/as expected

[1] Significance of the declines in adult population levels. *** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$.

[2] Survival assessments are based on two comparisons: (1) with body mass and (2) with survival in the Northwestern Maps region as a whole. When only one assessment is given it indicates that both of these comparisons coincided.

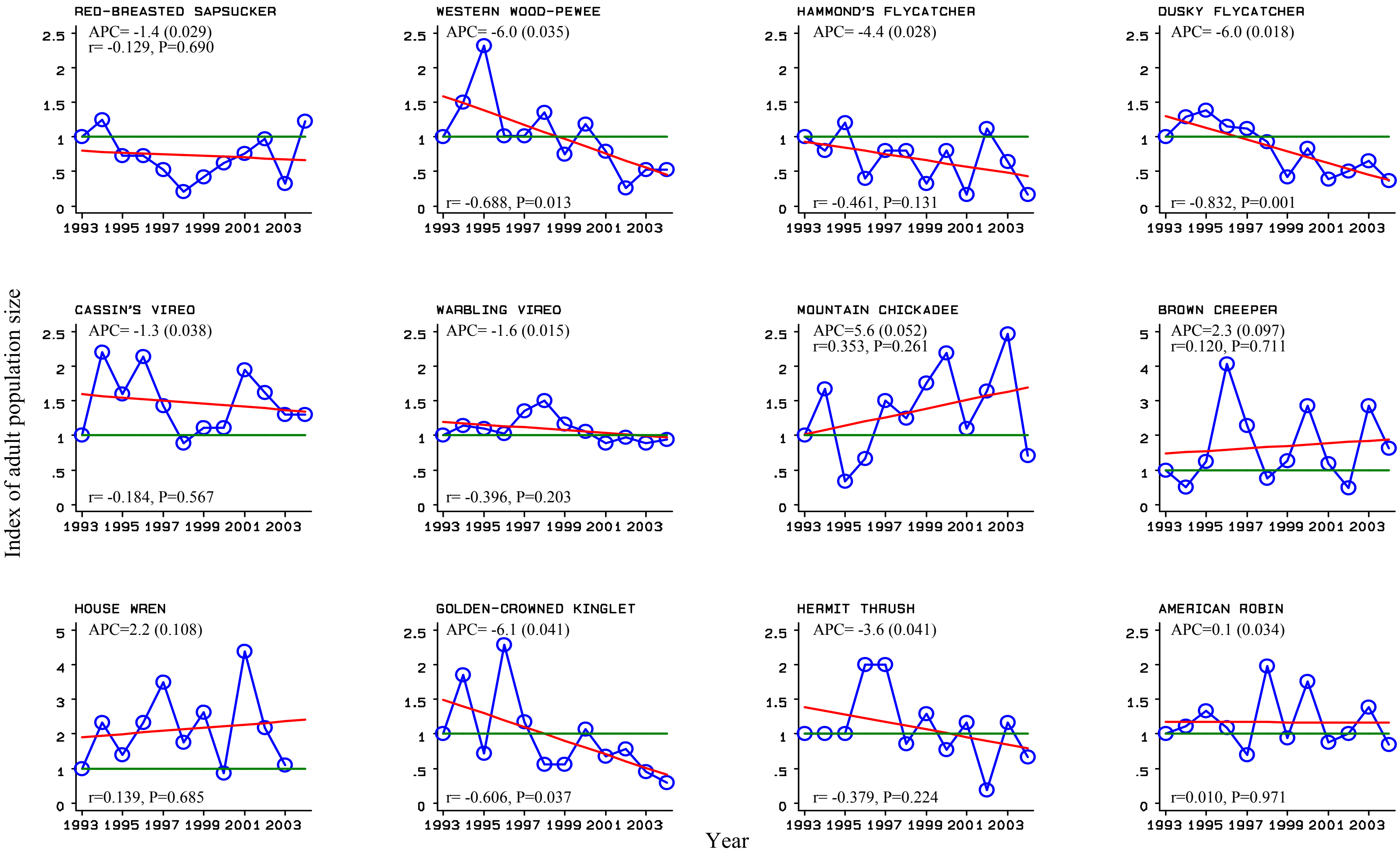

Figure 1. Population trends for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

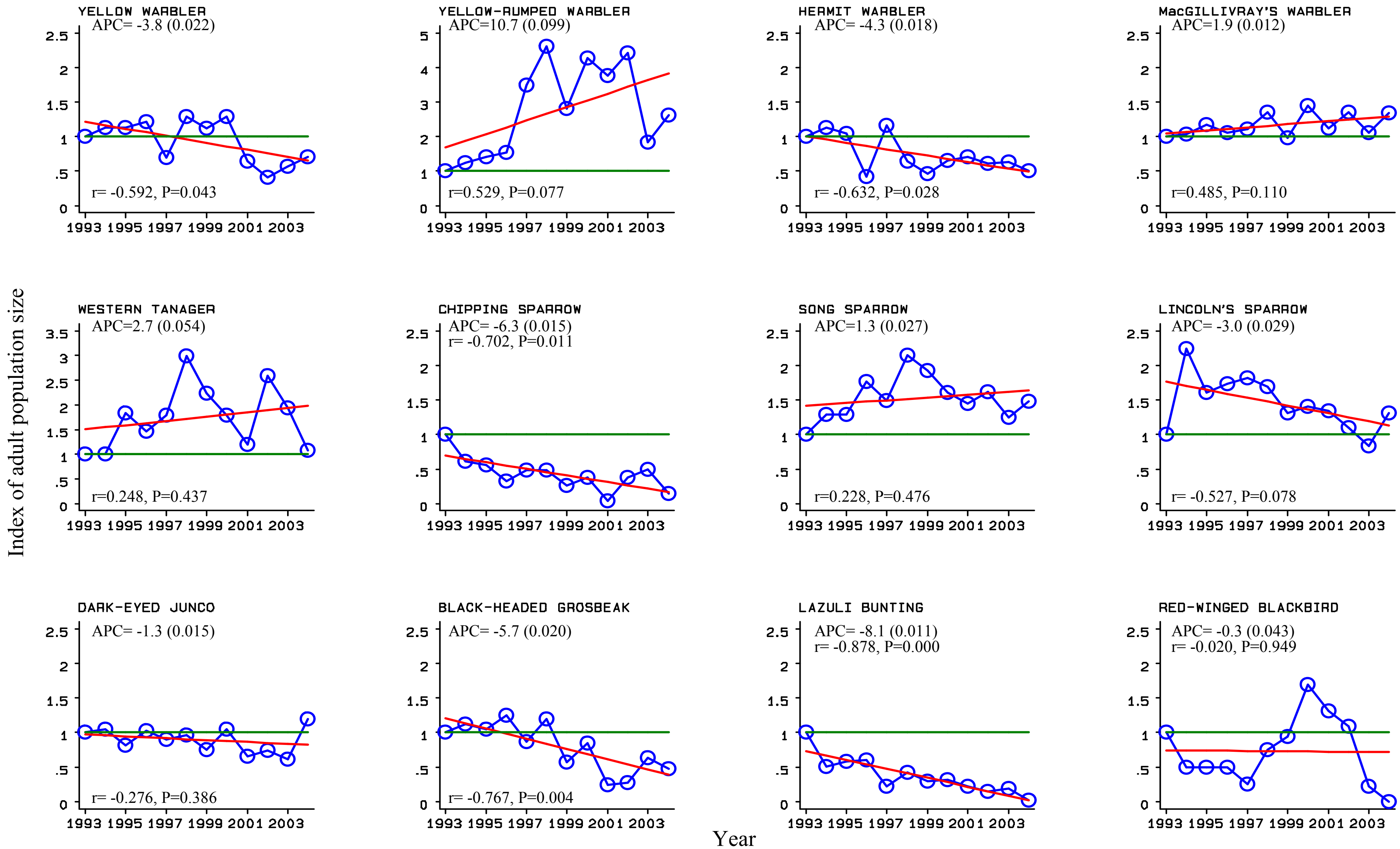

Figure 1. (cont.) Population trends for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

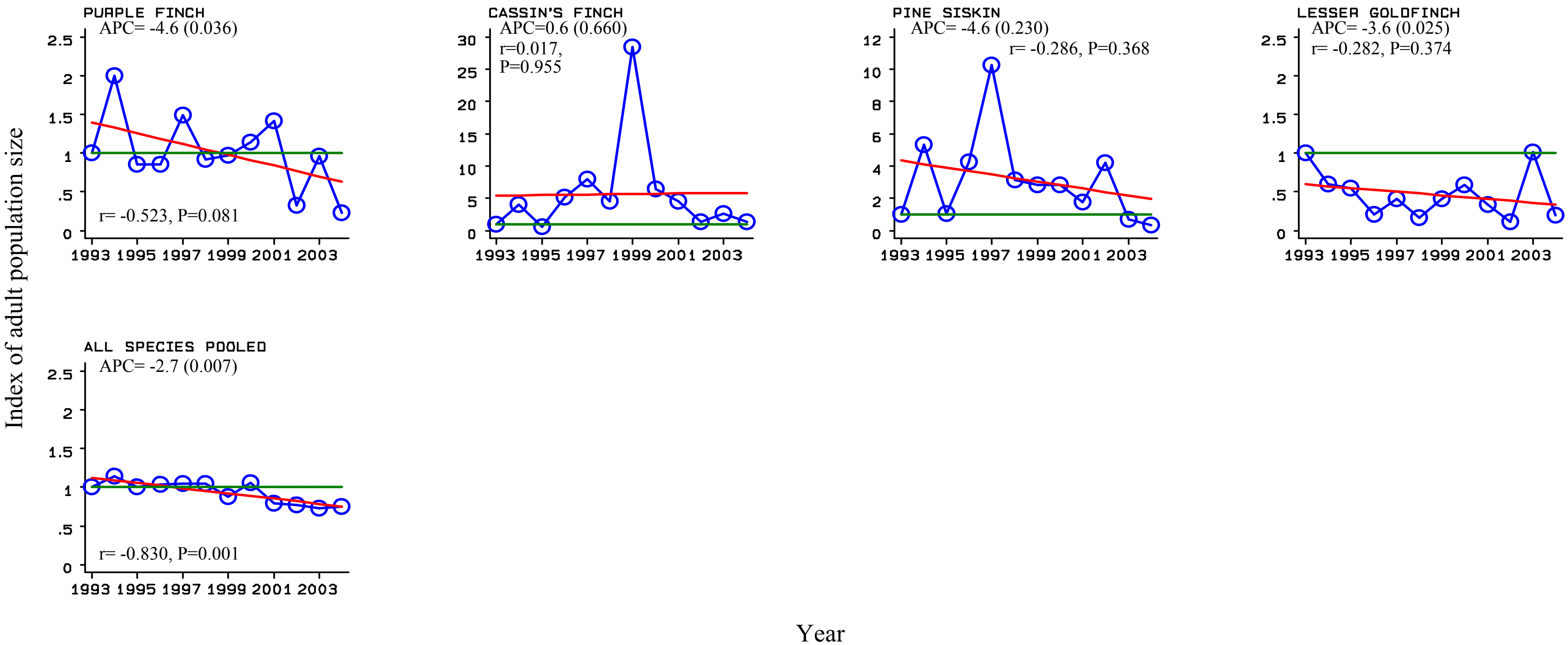

Figure 1. (cont.) Population trends for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

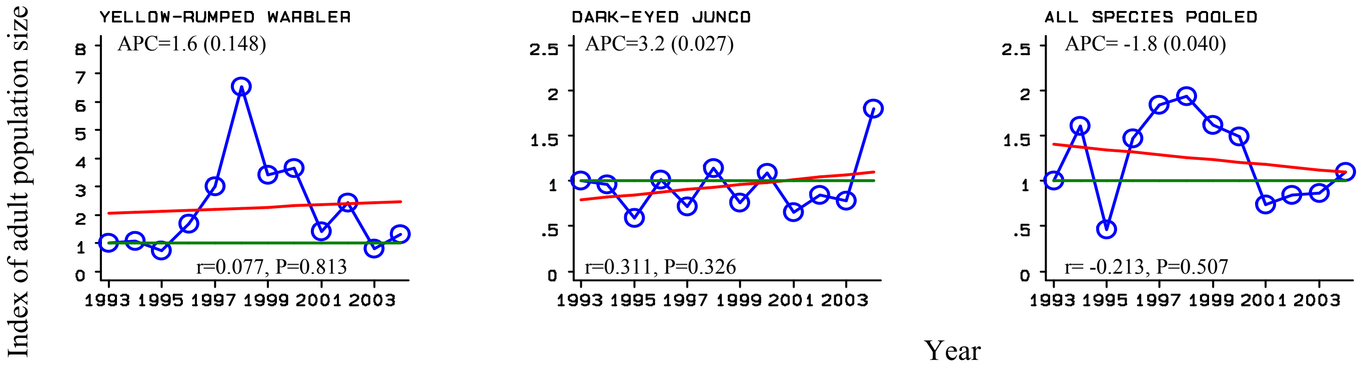

Figure 2. Population trends for two species and all species pooled at the White Wolf MAPS station in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

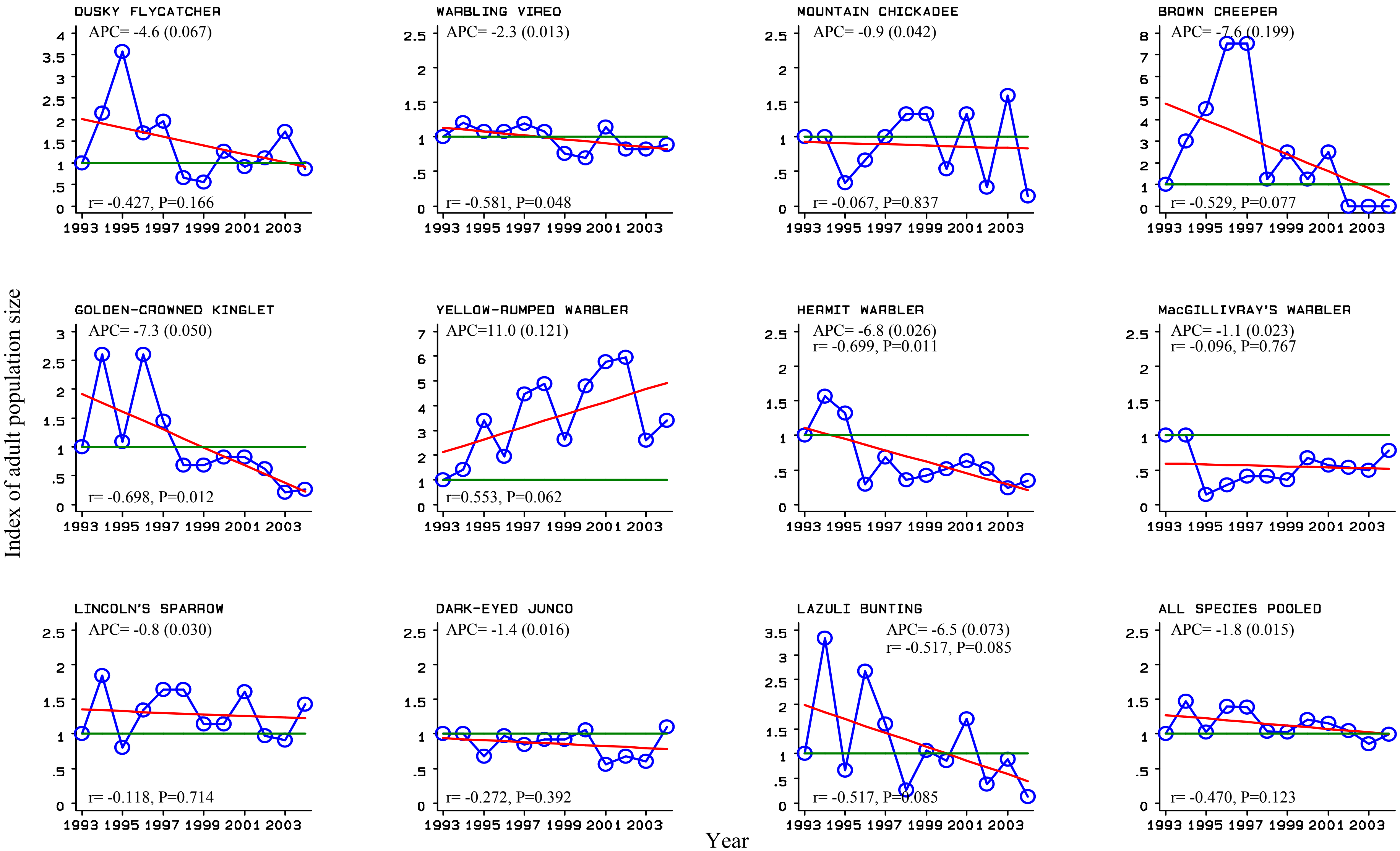

Figure 3. Population trends for 11 species and all species pooled at the Crane Flat MAPS station in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

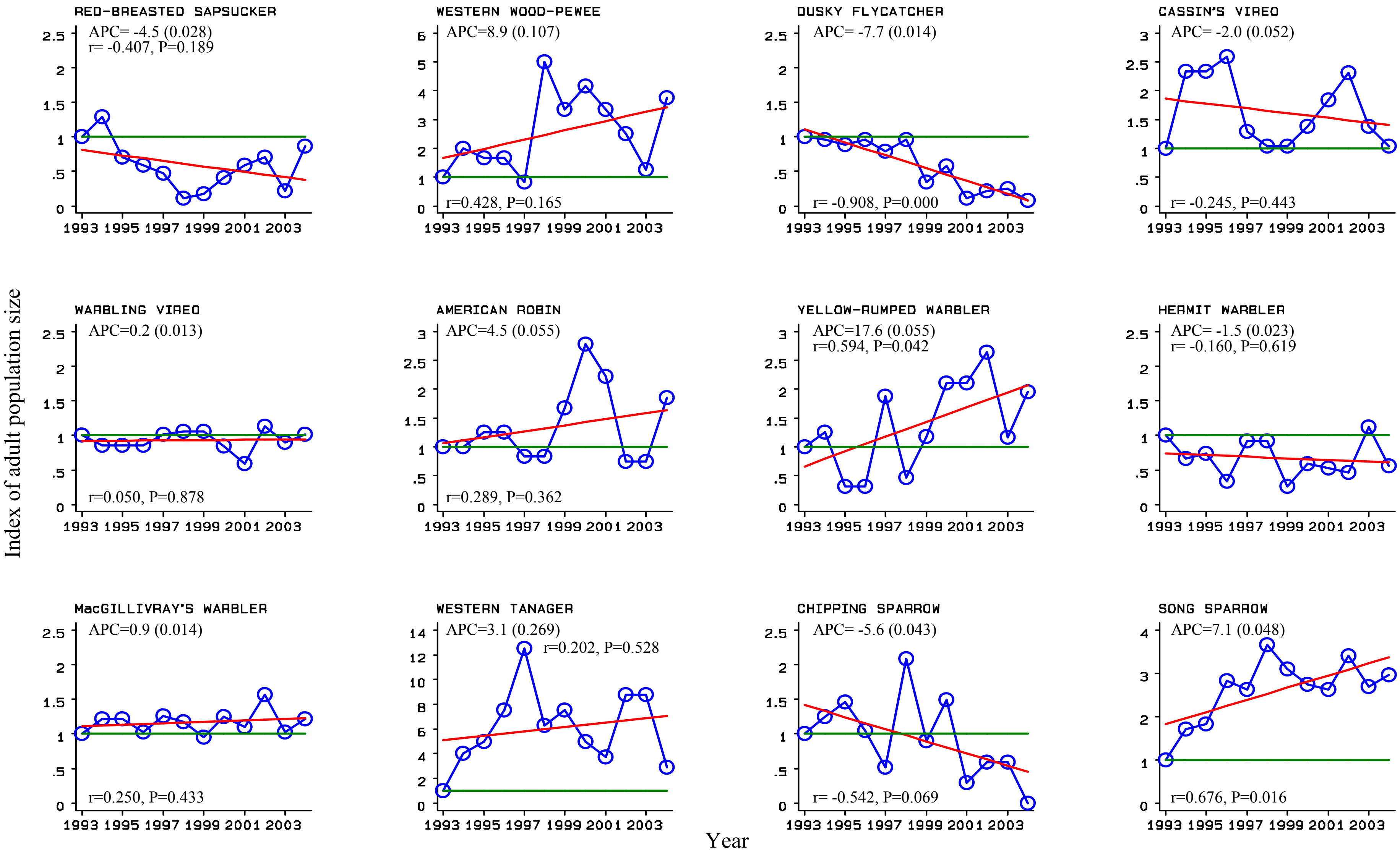

Figure 4. Population trends for 17 species and all species pooled at the Hodgdon Meadow MAPS station in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

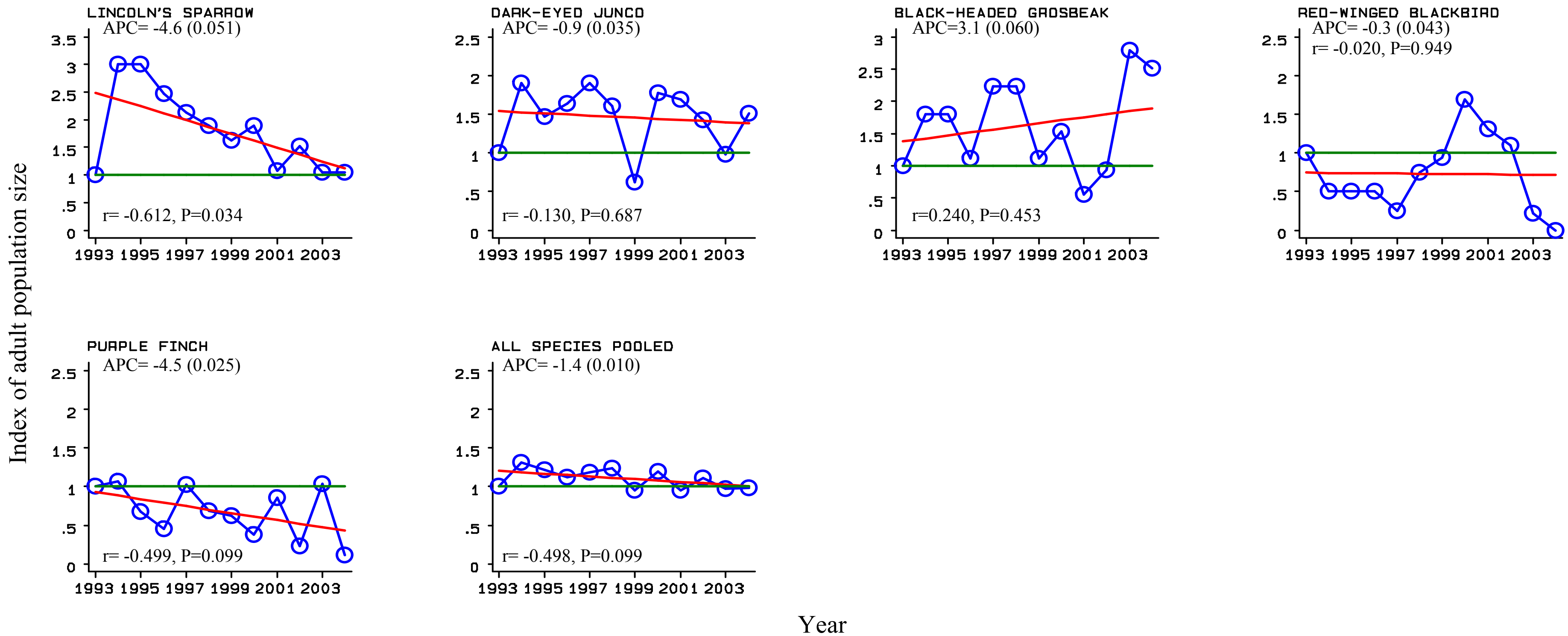

Figure 4. (cont.) Population trends for 17 species and all species pooled at the Hodgdon Meadow MAPS station in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

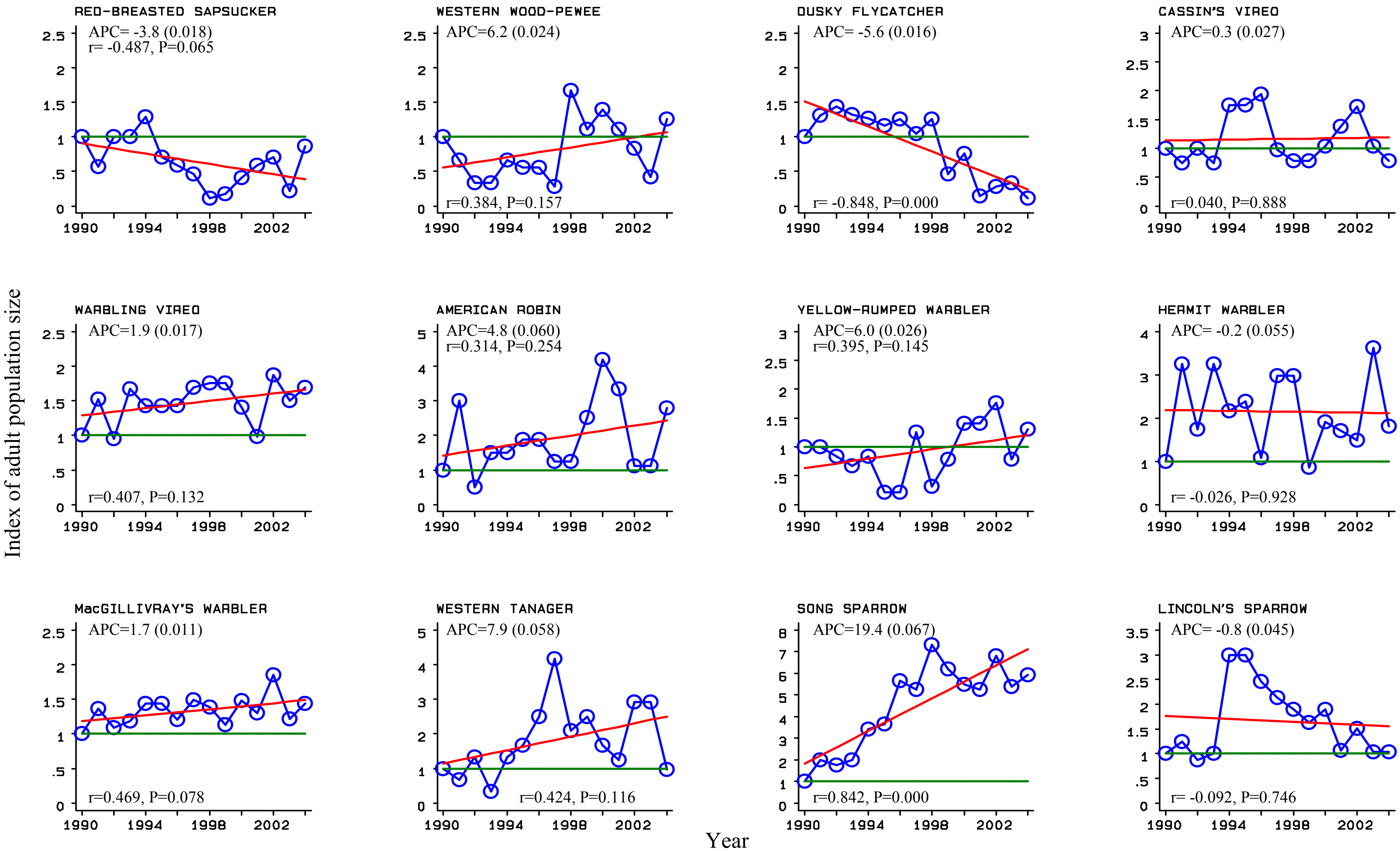

Figure 5. Population trends for 15 species and all species pooled at the Hodgdon Meadow MAPS station in Yosemite National Park over the 15 years 1990-2004. The index of population size was arbitrarily defined as 1.0 in 1990. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

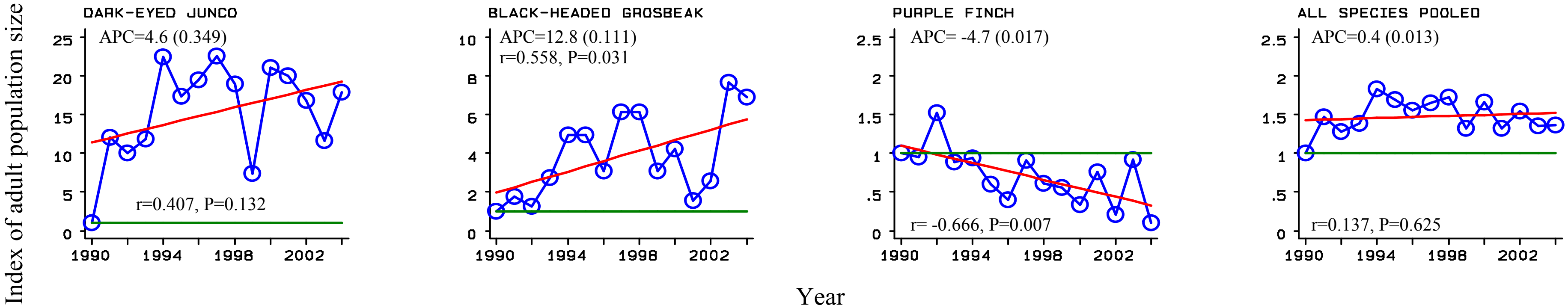

Figure 5. (cont.) Population trends for 15 species and all species pooled at the Hodgdon Meadow MAPS station in Yosemite National Park over the 15 years 1990-2004. The index of population size was arbitrarily defined as 1.0 in 1990. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

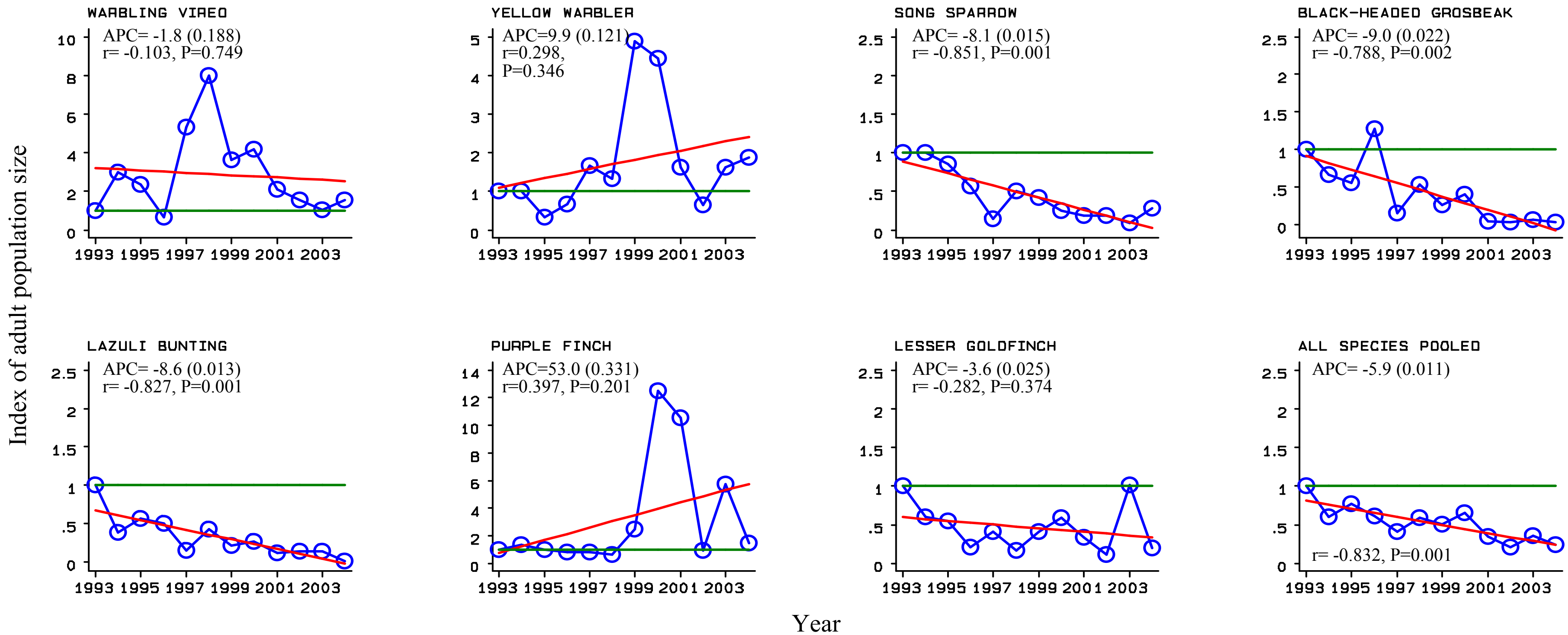

Figure 6. Population trends for seven species and all species pooled at the Big Meadow MAPS station in Yosemite National Park over the 12 years 1993-2004. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

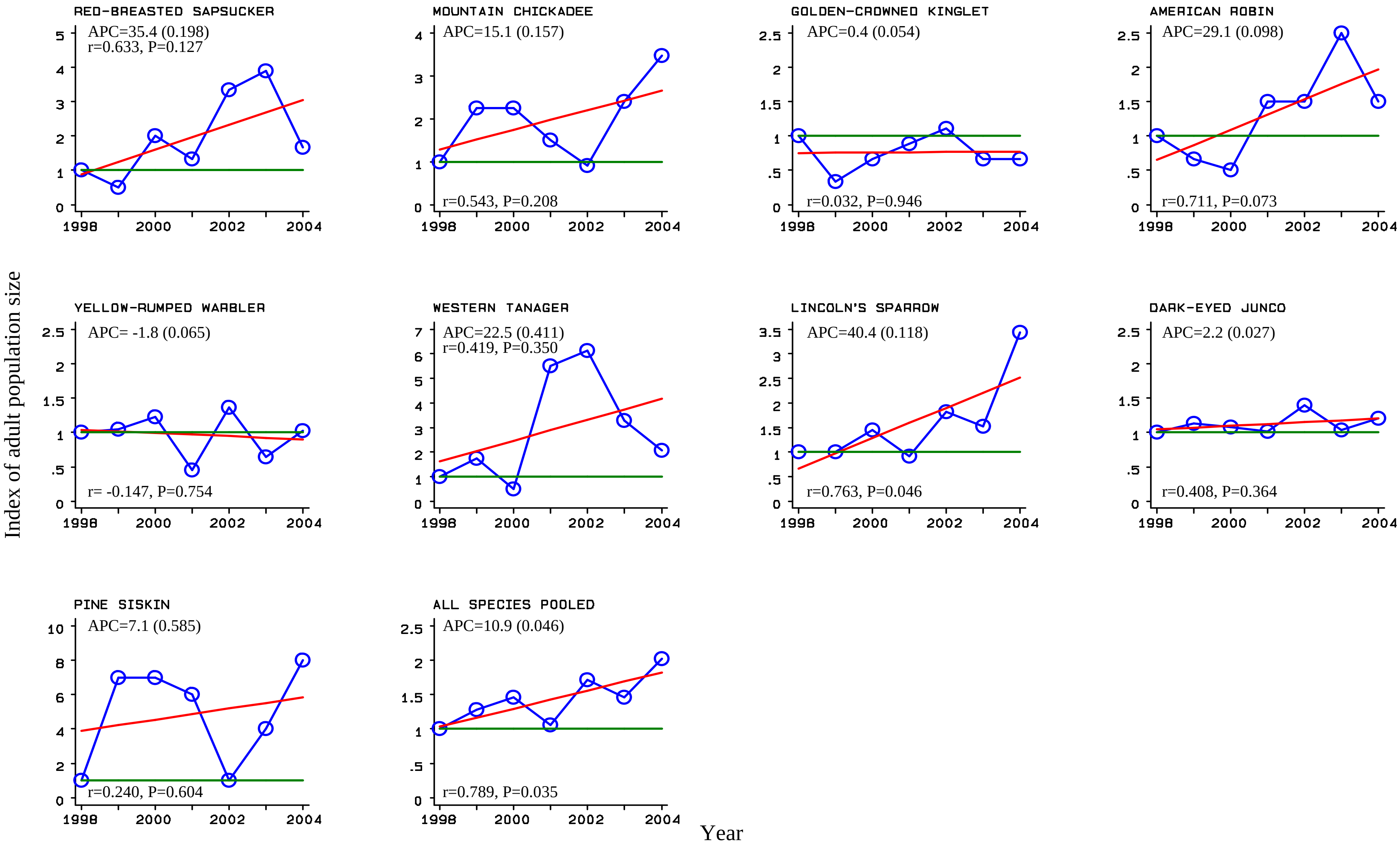

Figure 7. Population trends for nine species and all species pooled at the Gin Flat East Meadow MAPS station in Yosemite National Park over the seven years 1998-2004. The index of population size was arbitrarily defined as 1.0 in 1998. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

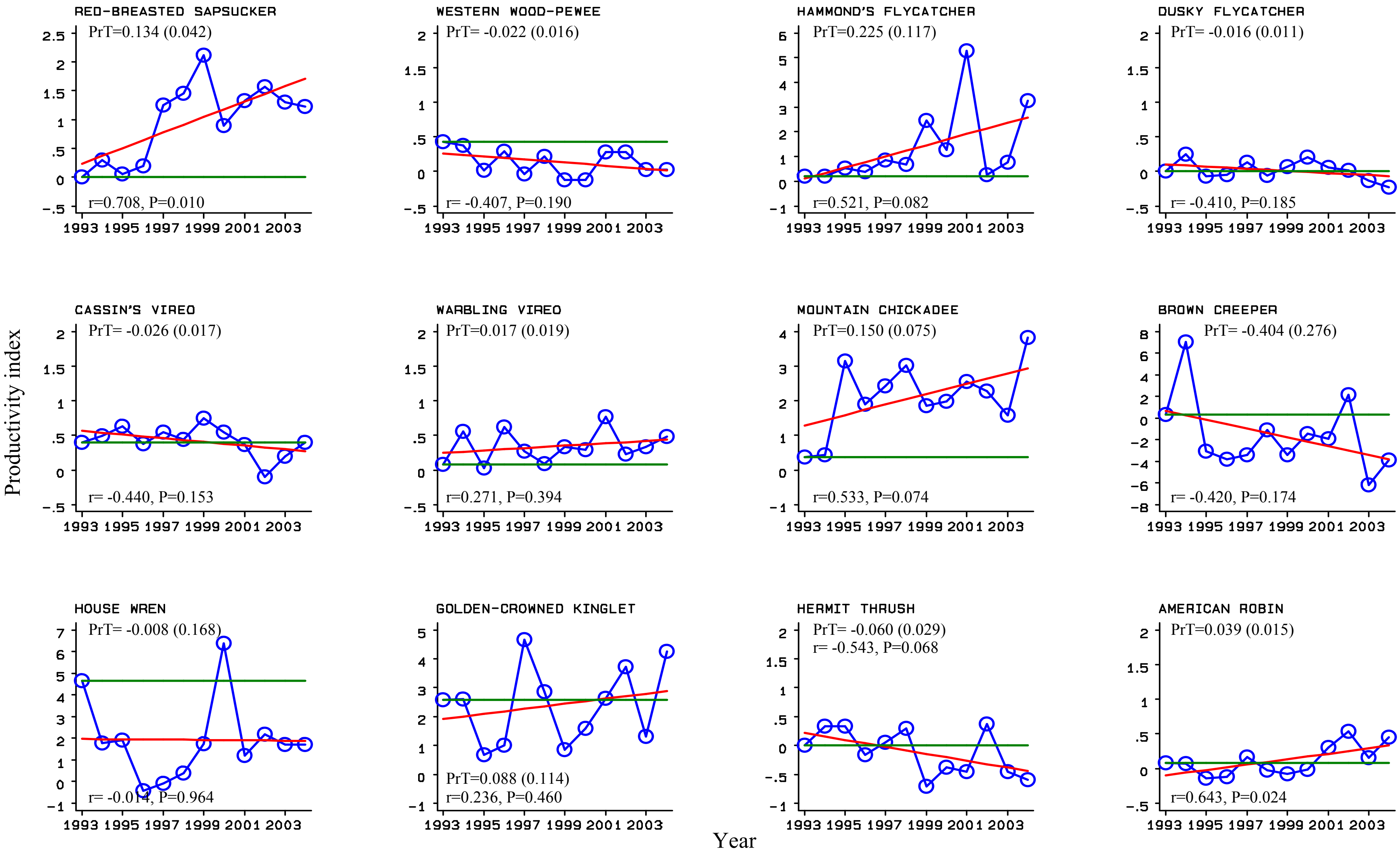

Figure 8. Trend in productivity for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The productivity index was defined as the actual productivity value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

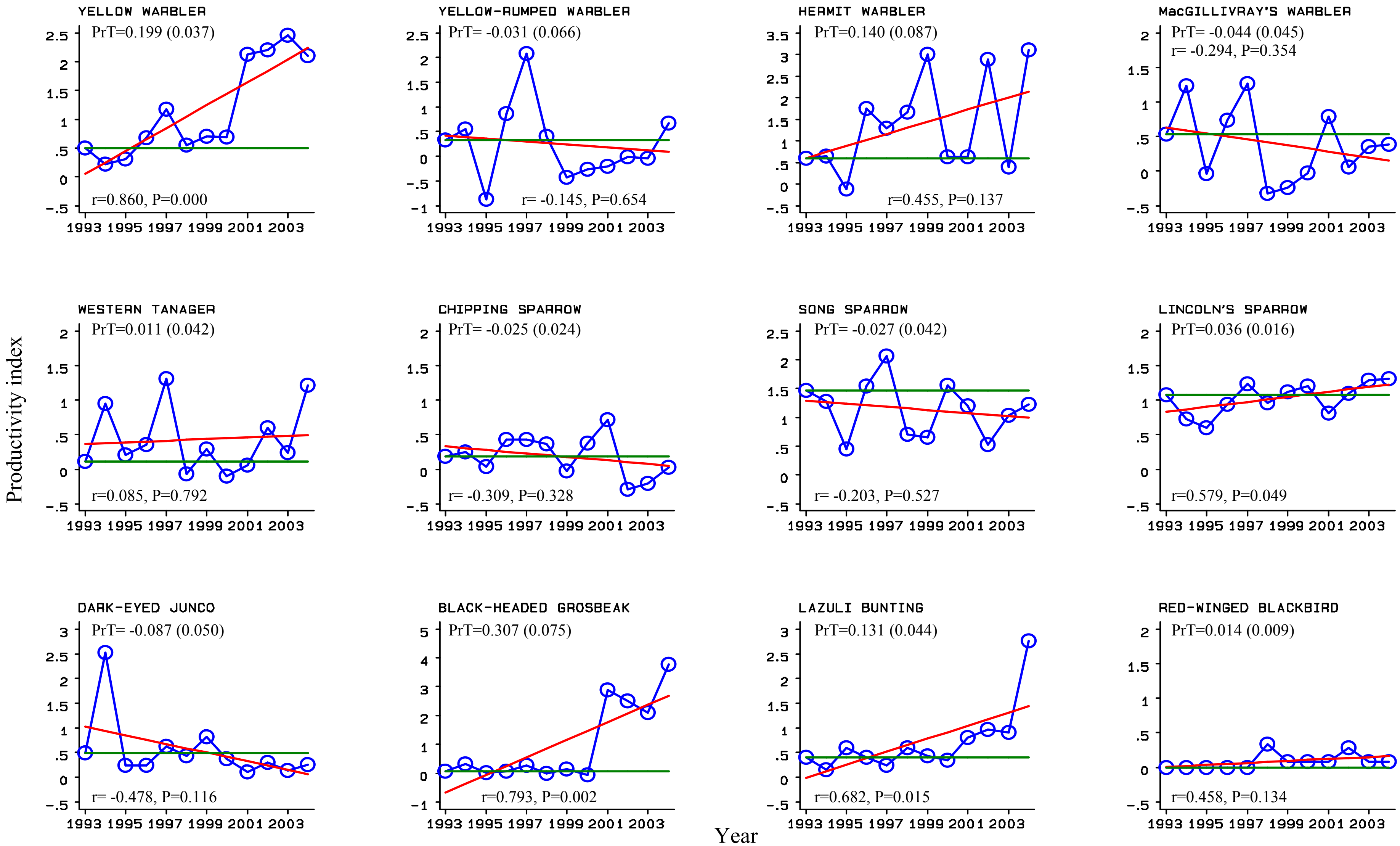

Figure 8. (cont.) Trend in productivity for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The productivity index was defined as the actual productivity value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

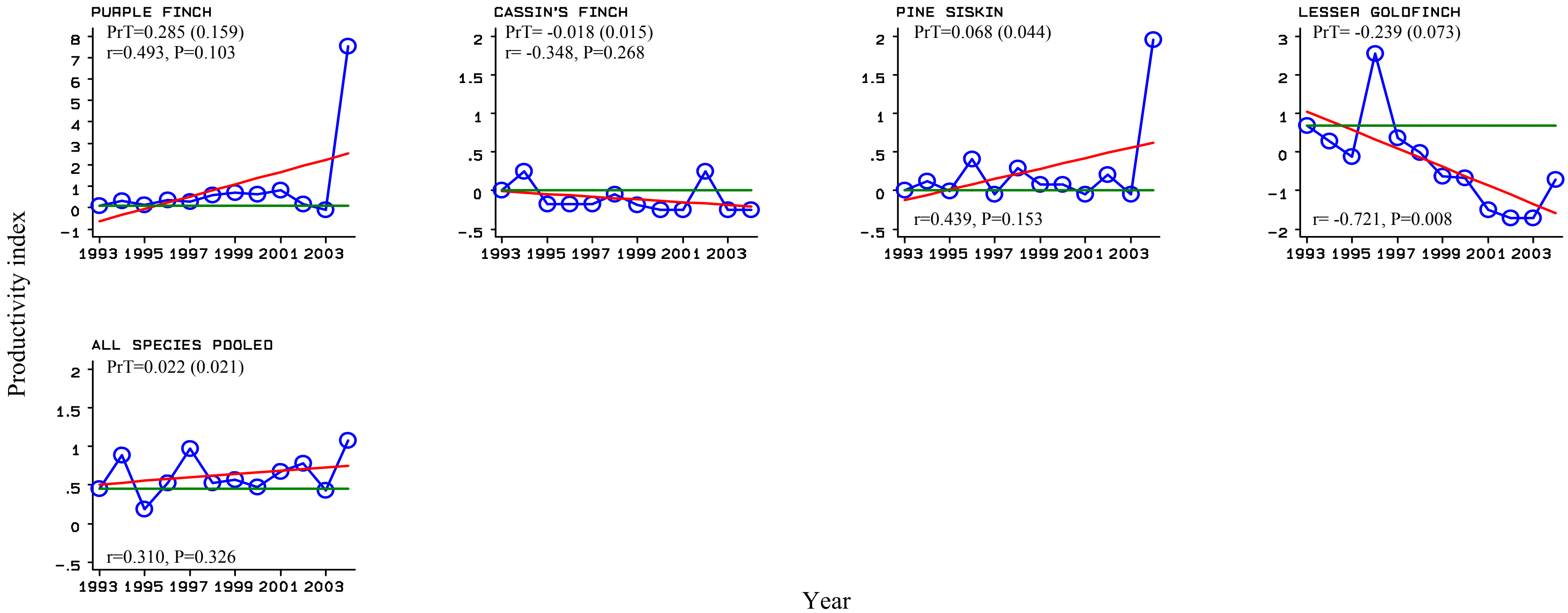

Figure 8. (cont.) Trend in productivity for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the 12 years 1993-2004. The productivity index was defined as the actual productivity value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

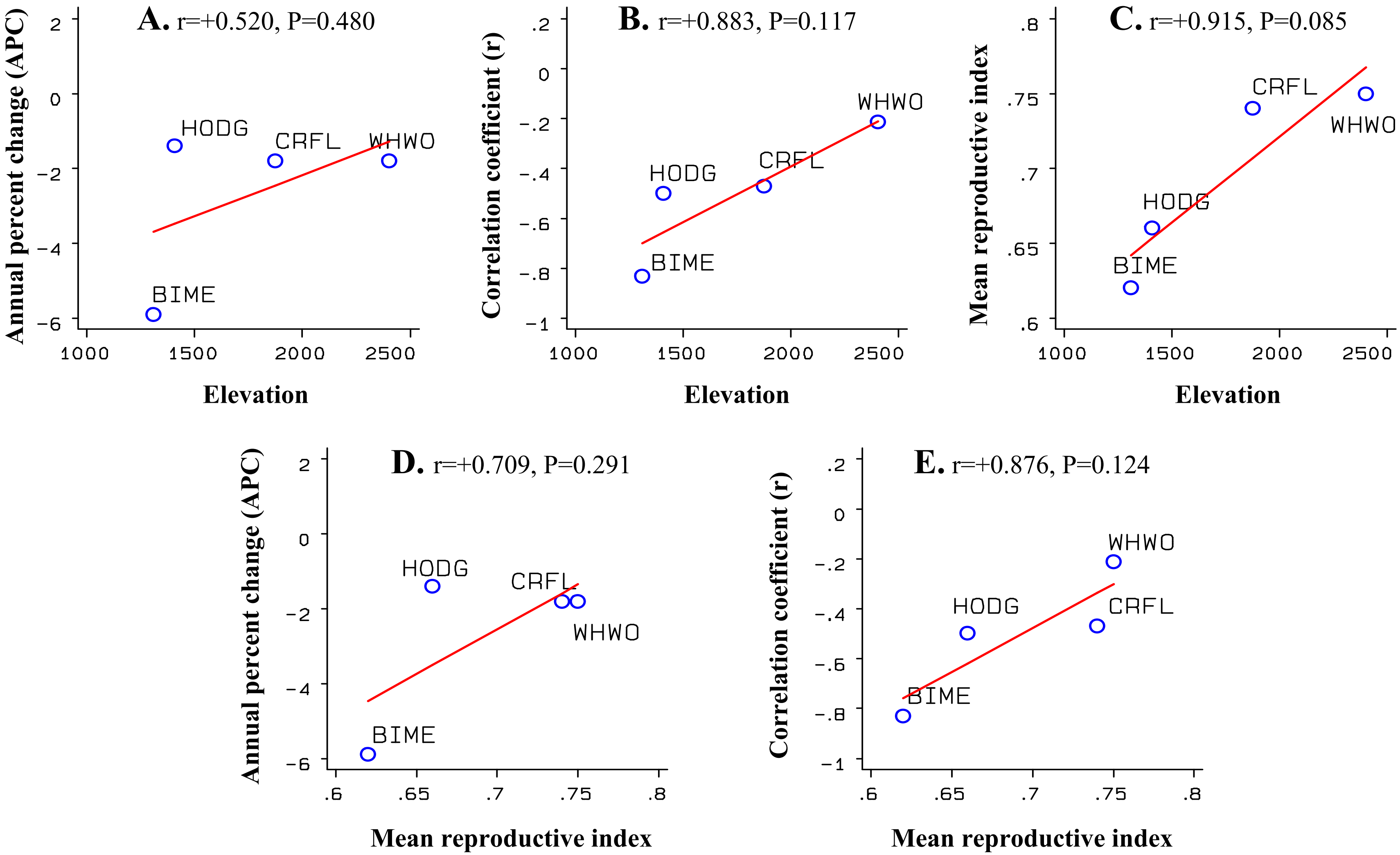

Figure 9. Five correlations of population indices for all species pooled at the four long running MAPS stations at Yosemite National Park over the 12 years 1993-2004. The correlations are: A. the annual percent change (APC) in adult population index against elevation, B. the correlation coefficient of adult population size against elevation, C. the mean reproductive index over all years against elevation, D. the annual percent change (APC) in adult population index against the mean reproductive index over all years, E. the correlation coefficient of adult population size against the mean reproductive index over all years. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are shown on each graph. WHWO -White Wolf; CRFL - Crane Flat, HODG - Hodgdon Meadow, BIME - Big Meadow

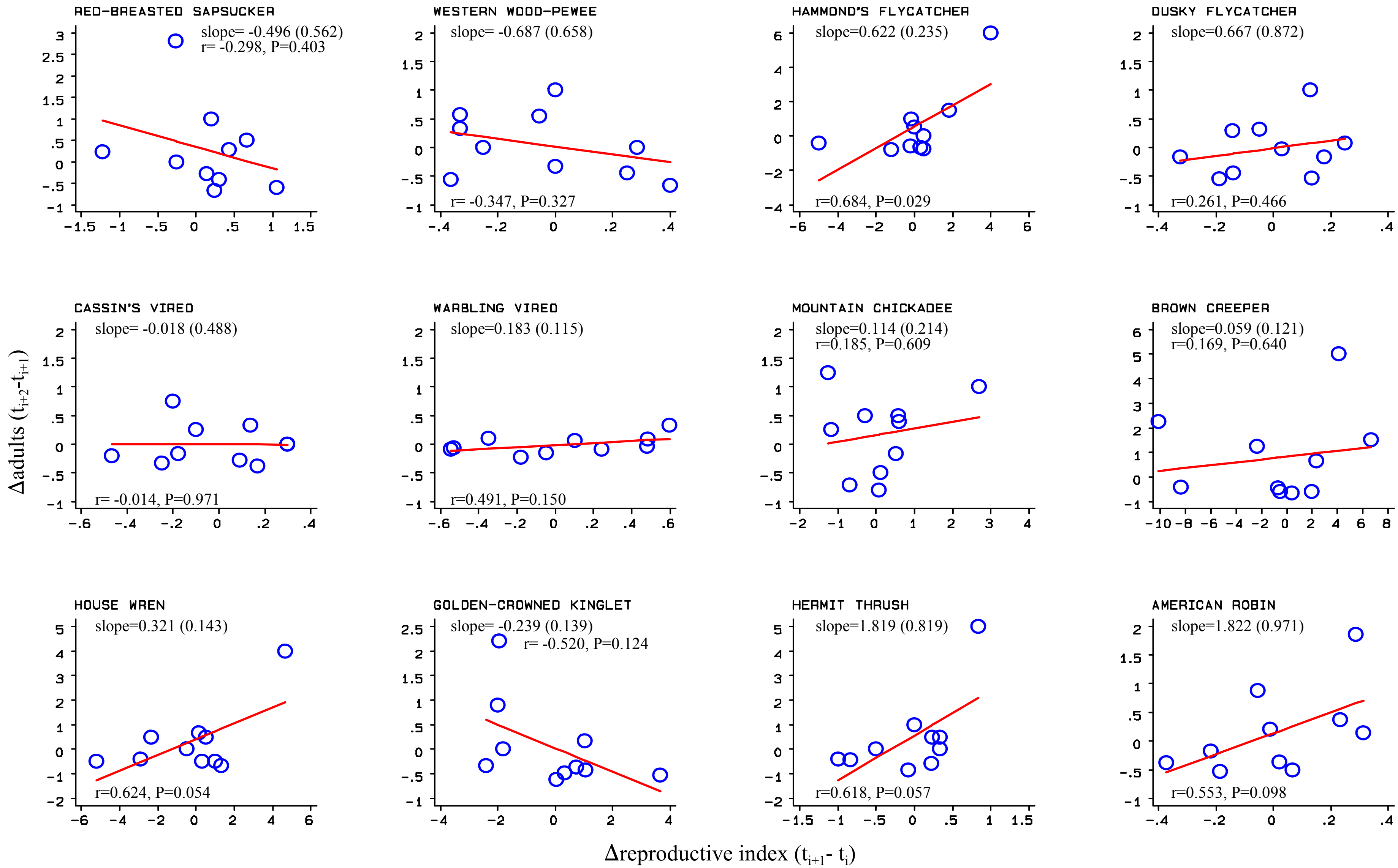

Figure 10. The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the years 1993-2004. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.

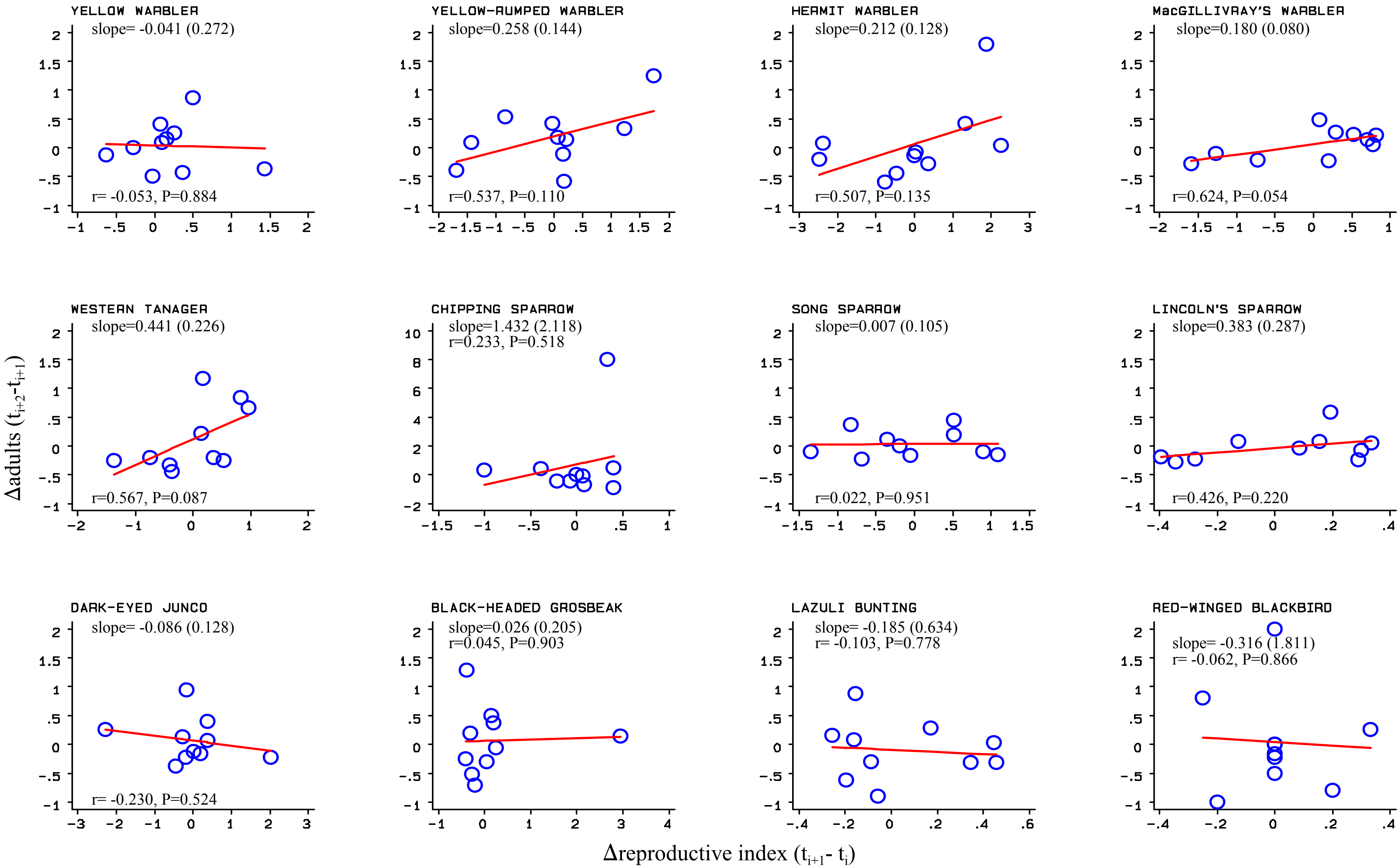

Figure 10. (cont.) The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the years 1993-2004. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.

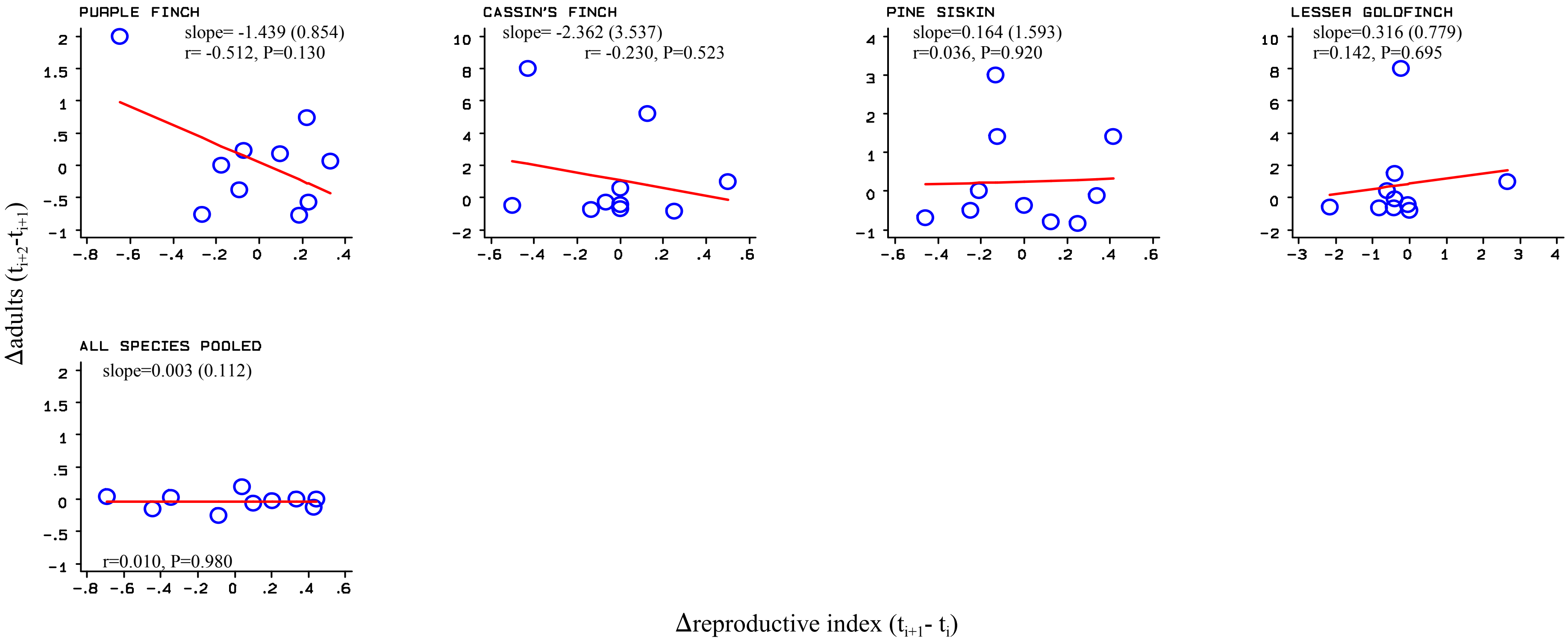

Figure 10. (cont.) The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 28 species and all species pooled at the four long running MAPS stations in Yosemite National Park over the years 1993-2004. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.

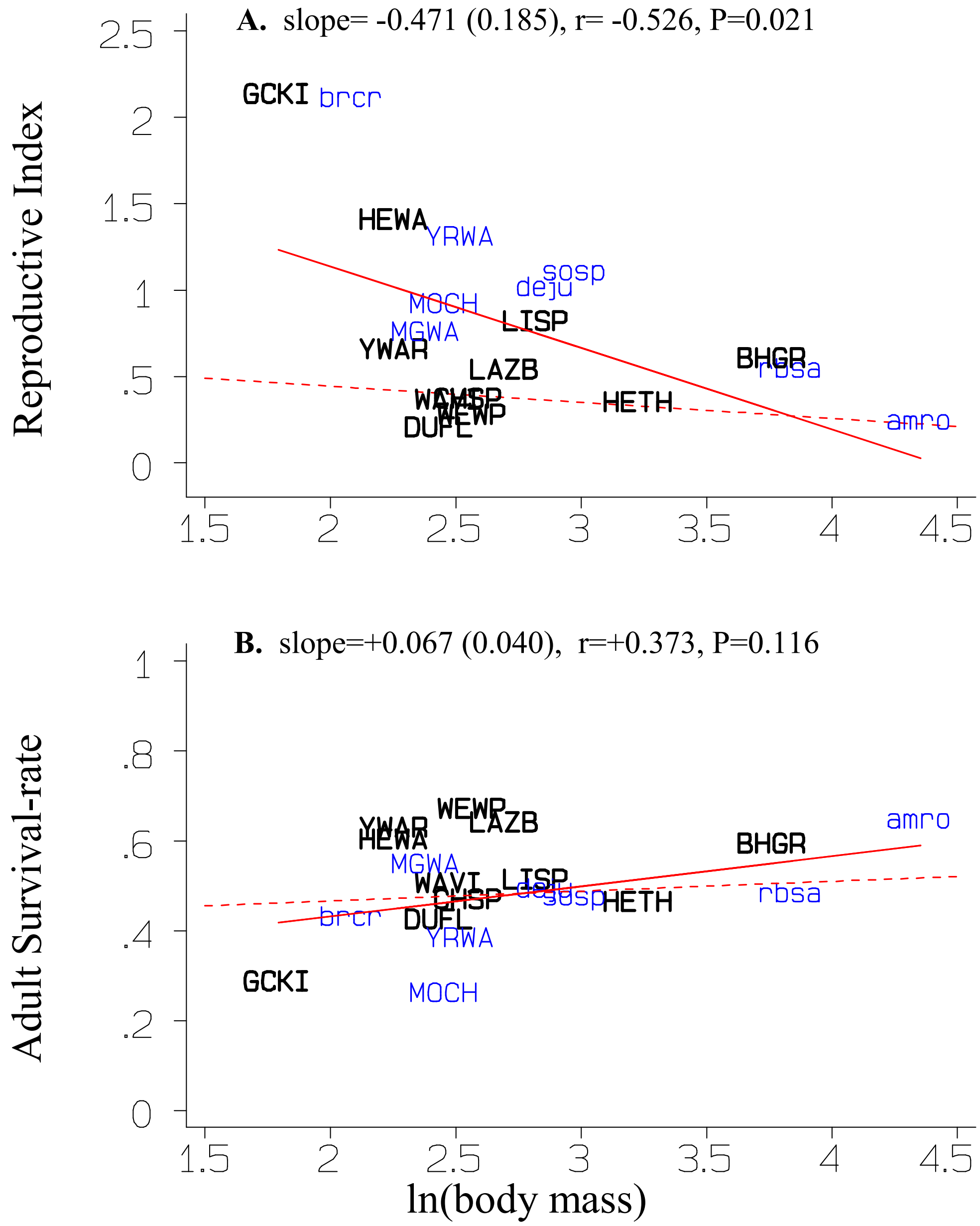

Figure 11. Regressions of mean reproductive index (**A**) and time-constant annual adult survival rate (**B**), at the five currently operating MAPS stations in Yosemite National Park, on the natural log of body mass for 19 target species. Target species were included if the survival estimate for the species was reliable (i.e. there were at least 5 returns, SE(ϕ)≤0.2 and CV(ϕ)<50% for the 12 years 1993-2004) and if the reproductive index was defined in each of the 12 years (i.e. at least one constant effort adult was captured in every year). Four-letter codes (see Appendix I) in bold upper-case letters represent species that had decreasing population trends (r < -0.30); those in non-bold upper-case letters had increasing trends (r > 0.30); and those in lower-case letters had highly fluctuating data without any substantial linear trend (-0.30≥ r ≤0.30). Regression lines are presented for the 19 target species in Yosemite National Park (solid line) and for all species throughout all of North America (dashed line; see text). The slope, the r-value, and P-value are presented for the regression of the 19 target species.

Appendix I. Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 15 years, 1990-2004, of the MAPS Program on the six stations ever operated in Yosemite National Park.

NUMB	SPEC	SPECIES NAME
01010	GBHE	Great Blue Heron
01300	TUVU	Turkey Vulture
01630	MALL	Mallard
01980	COME	Common Merganser
02020	OSPR	Osprey
02170	NOHA	Northern Harrier
02200	SSHA	Sharp-shinned Hawk
02210	COHA	Cooper's Hawk
02240	NOGO	Northern Goshawk
02380	RSHA	Red-shouldered Hawk
02460	RTHA	Red-tailed Hawk
02510	GOEA	Golden Eagle
02545	UNHA	Unidentified Hawk
02630	AMKE	American Kestrel
03000	BLUG	Blue Grouse
03040	WITU	Wild Turkey
03100	MOUQ	Mountain Quail
03130	CAQU	California Quail
03370	VIRA	Virginia Rail
05440	BTPI	Band-tailed Pigeon
05570	MODO	Mourning Dove
06670	WESO	Western Screech-Owl
06800	GHOW	Great Horned Owl
06830	NOPO	Northern Pygmy-Owl
06940	SPOW	Spotted Owl
06970	GGOW	Great Gray Owl
07040	NSWO	Northern Saw-whet Owl
07330	BLSW	Black Swift
07410	VASW	Vaux's Swift
07530	WTSW	White-throated Swift
08640	BCHU	Black-chinned Hummingbird
08670	ANHU	Anna's Hummingbird
08690	CAHU	Calliope Hummingbird
08730	RUHU	Rufous Hummingbird
08740	ALHU	Allen's Hummingbird
08774	USHU	Unidentified Selasphorus Hummingbird
08775	UNHU	Unidentified Hummingbird
09110	BEKI	Belted Kingfisher
09390	LEWO	Lewis's Woodpecker
09430	ACWO	Acorn Woodpecker

Appendix I. (cont.) Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 15 years, 1990-2004, of the MAPS Program on the six stations ever operated in Yosemite National Park.

NUMB	SPEC	SPECIES NAME
09570	WISA	Williamson's Sapsucker
09600	RBSA	Red-breasted Sapsucker
09640	NUWO	Nuttall's Woodpecker
09650	DOWO	Downy Woodpecker
09660	HAWO	Hairy Woodpecker
09690	WHWO	White-headed Woodpecker
09710	BBWO	Black-backed Woodpecker
09800	RSFL	Red-shafted Flicker
09860	PIWO	Pileated Woodpecker
09915	UNWO	Unidentified Woodpecker
11340	OSFL	Olive-sided Flycatcher
11380	WEWP	Western Wood-Pewee
11475	TRFL	"Traill's" Flycatcher
11475	WIFL	Willow Flycatcher
11510	HAFL	Hammond's Flycatcher
11515	HDFL	Hammond's/Dusky Flycatcher
11520	GRFL	Gray Flycatcher
11530	DUFL	Dusky Flycatcher
11555	PSFL	Pacific-slope Flycatcher
11555	WEFL	"Western" Flycatcher
11595	UEFL	Unidentified Empidonax Flycatcher
11600	BLPH	Black Phoebe
11740	ATFL	Ash-throated Flycatcher
12020	WEKI	Western Kingbird
12085	UNFL	Unidentified Flycatcher
12710	CAVI	Cassin's Vireo
12740	HUVI	Hutton's Vireo
12760	WAVI	Warbling Vireo
12790	REVI	Red-eyed Vireo
12920	STJA	Steller's Jay
13110	WESJ	Western Scrub-Jay
13150	CLNU	Clark's Nutcracker
13190	AMCR	American Crow
13300	CORA	Common Raven
13410	TRES	Tree Swallow
13440	VGSW	Violet-green Swallow
13490	NRWS	Northern Rough-winged Swallow
13540	BARS	Barn Swallow
13555	UNSW	Unidentified Swallow
13580	MOCH	Mountain Chickadee

Appendix I. (cont.) Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 15 years, 1990-2004, of the MAPS Program on the six stations ever operated in Yosemite National Park.

NUMB	SPEC	SPECIES NAME
13600	CBCH	Chestnut-backed Chickadee
13640	OATI	Oak Titmouse
13680	BUSH	Bushtit
13690	RBNU	Red-breasted Nuthatch
13700	WBNU	White-breasted Nuthatch
13710	PYNU	Pygmy Nuthatch
13730	BRCR	Brown Creeper
14040	BEWR	Bewick's Wren
14070	HOWR	House Wren
14110	WIWR	Winter Wren
14205	UNWR	Unidentified Wren
14210	AMDI	American Dipper
14240	GCKI	Golden-crowned Kinglet
14250	RCKI	Ruby-crowned Kinglet
14570	WEBL	Western Bluebird
14590	TOSO	Townsend's Solitaire
14810	SWTH	Swainson's Thrush
14820	HETH	Hermit Thrush
15000	AMRO	American Robin
15110	WREN	Wrentit
15370	EUST	European Starling
15550	CEDW	Cedar Waxwing
15660	OCWA	Orange-crowned Warbler
15670	NAWA	Nashville Warbler
15750	YWAR	Yellow Warbler
15800	AUWA	Audubon's Warbler
15810	BTYW	Black-throated Gray Warbler
15840	TOWA	Townsend's Warbler
15850	HEWA	Hermit Warbler
16040	AMRE	American Redstart
16090	NOWA	Northern Waterthrush
16140	MGWA	MacGillivray's Warbler
16150	COYE	Common Yellowthroat
16280	HOWA	Hooded Warbler
16290	WIWA	Wilson's Warbler
16460	YBCH	Yellow-breasted Chat
16495	UNWA	Unidentified Warbler
16840	WETA	Western Tanager
17790	GTTO	Green-tailed Towhee
17810	SPTO	Spotted Towhee

Appendix I. (cont.) Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 15 years, 1990-2004, of the MAPS Program on the six stations ever operated in Yosemite National Park.

NUMB	SPEC	SPECIES NAME
17850	CALT	California Towhee
18020	CHSP	Chipping Sparrow
18110	SAGS	Sage Sparrow
18130	SAVS	Savannah Sparrow
18220	FOSP	Fox Sparrow
18230	SOSP	Song Sparrow
18240	LISP	Lincoln's Sparrow
18290	MWCS	Mountain White-crowned Sparrow
18320	ORJU	Oregon Junco
18335	UNSP	Unidentified Sparrow
18600	RBGR	Rose-breasted Grosbeak
18610	BHGR	Black-headed Grosbeak
18660	LAZB	Lazuli Bunting
18670	INBU	Indigo Bunting
18730	RWBL	Red-winged Blackbird
18810	WEME	Western Meadowlark
18820	YHBL	Yellow-headed Blackbird
18860	BRBL	Brewer's Blackbird
18960	BHCO	Brown-headed Cowbird
19105	BUOR	Bullock's Oriole
19330	PIGR	Pine Grosbeak
19350	PUFI	Purple Finch
19360	CAFI	Cassin's Finch
19370	HOFI	House Finch
19375	UCFI	Unidentified Carpodacus Finch
19380	RECR	Red Crossbill
19430	PISI	Pine Siskin
19490	LEGO	Lesser Goldfinch
19500	LAGO	Lawrence's Goldfinch
19510	AMGO	American Goldfinch
19580	EVGR	Evening Grosbeak
19920	HOSP	House Sparrow
20085	UNBI	Unidentified Bird